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THE CONDOR

VOLUME 58 MAY-JUNE, 1956 NUMBER 3

TERRITORIALITY AND SURVIVAL IN THE PLAIN TITMOUSE

By KEITH L. DIXON

The study of territoriality in the Plain Titmouse (*Parus inornatus*) is of interest because of the extreme development of this behavior in some of its populations. Investigations of several species of the genus *Parus* (summarized by Hinde, 1952) have demonstrated that adults of most of them tend to be sedentary and that pairing for life appears to be the rule. These trends are accentuated in those populations of the Plain Titmouse that inhabit the Pacific coastal slope of California. Adults generally remain paired permanently and confine their activities to their territories, which they defend throughout the year. Family groups break up a month or so after fledging takes place, and the juveniles leave their parents' territories. First-year Plain Titmice may be associated in pairs as early as August, and paired immature birds may take up territories by early autumn. Winter flocking is not known in this species in coastal California, although it has been reported for the "gray" races inhabiting interior piñon-juniper woodland by Aiken and Warren (1914:596) and by Woodbury and Russell (1945:93).

ACKNOWLEDGEMENTS

I am indebted to Alden H. Miller and Frank A. Pitelka for encouragement during the course of the field work on titmice and to George K. Reid, Jr., and W. B. Davis for suggestions concerning preparation of manuscript. Martha W. Dixon aided in the preparation of figures.

METHODS

The studies reported here were made from December, 1946, to May, 1948, and, intermittently, from February, 1950, until May, 1952. Thus five of six consecutive breeding seasons are represented by some detailed observations. During the latter three years, the field work was concentrated in the spring months; trapping and banding were conducted in May and June, both in 1950 and 1951, and in October, 1951. From 1946 through 1951, 61 titmice were color-banded, 22 as adults and 39 in their first six months of life. Information on activities of individuals was obtained by sight identification of these color-banded birds and to a lesser extent by trapping at elevated trays baited with walnut meat.

The study plot was in Strawberry Canyon, adjacent to the campus of the University of California, on the west slope of the Berkeley Hills in Alameda County, California. Its area was approximately 144 acres, not 44 as stated earlier (Dixon, 1954:121). Habitat suitable for titmice consists of streamside groves of alders (*Alnus rhombifolia*) and a woodland of live oak (*Quercus agrifolia*) and California laurel (*Umbellularia*) growing in adjacent parts of the canyon bottom and in tributary "draws," especially those on the south-facing slope. In the maps (figs. 1, 2, and 3), oak-laurel woodland is indicated by diagonal lines slanting downward to the left.

TERRITORIAL BOUNDARIES, 1947–1952

In the years from 1950 to 1952, territorial boundaries were mapped as they occurred in mid-May, whereas the limits shown for 1947 and 1948 were those existing in mid-

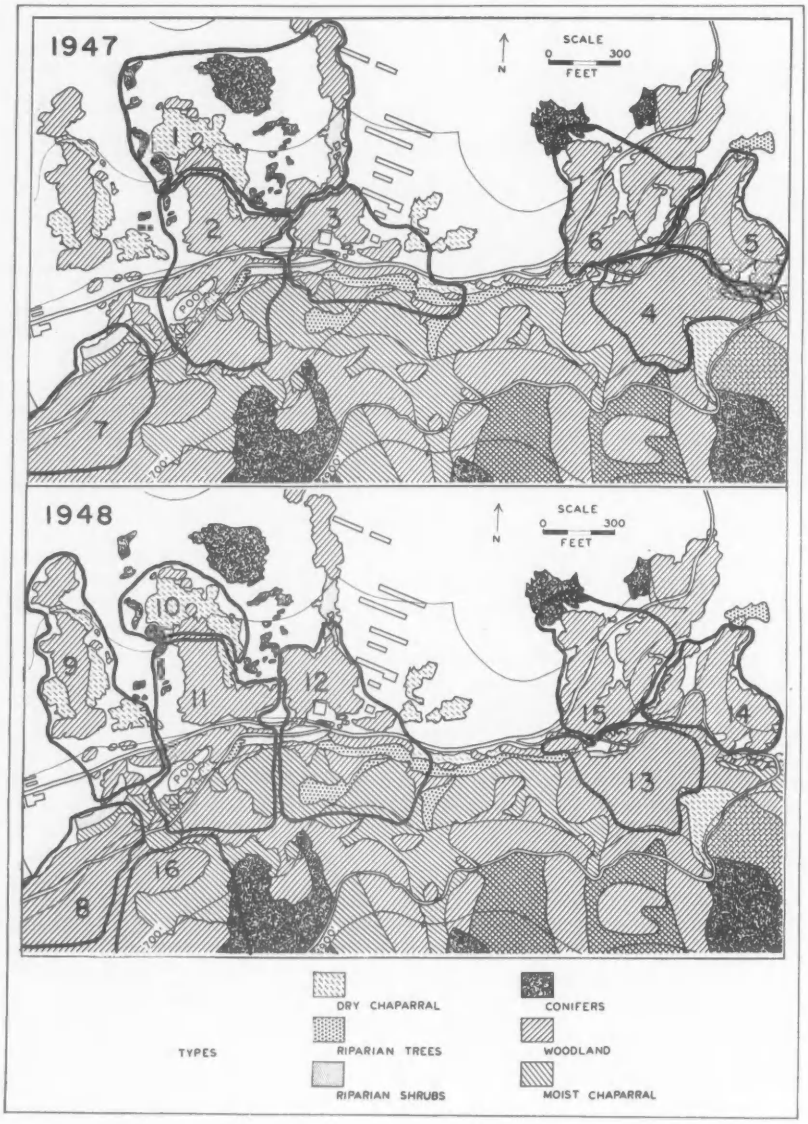

Fig. 1. Maps of territories of Plain Titmice in Strawberry Canyon, Alameda County, California, as of March 15, in 1947 and 1948.

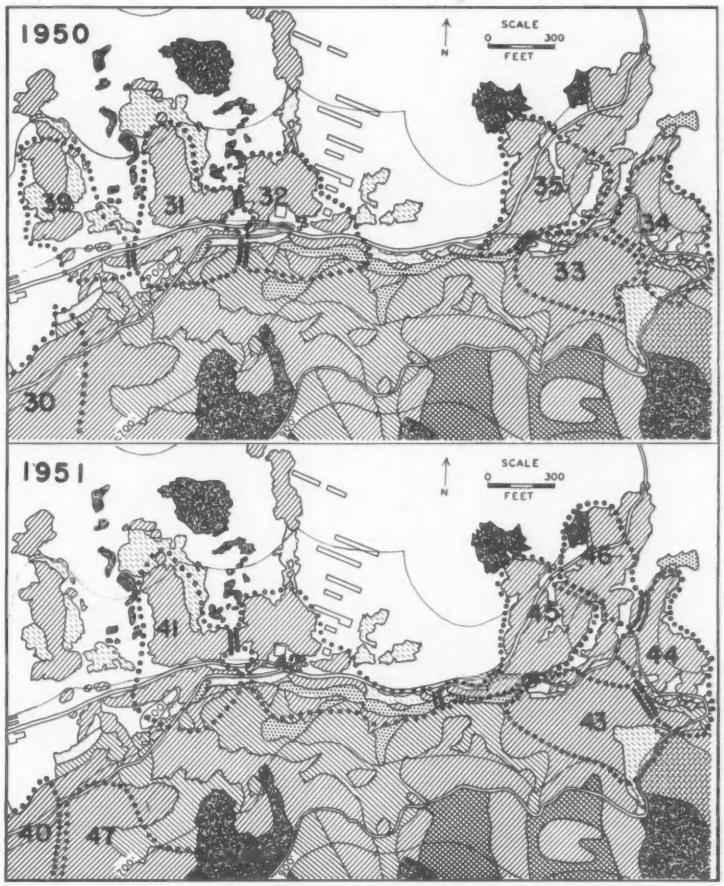

Fig. 2. Maps of territories of Plain Titmice in Strawberry Canyon as of May 15, in 1950 and 1951. Solid lines indicate those boundaries where defense actually was observed.

March. However, the boundaries fluctuated little from one season to the next, provided both members of a pair survived. In the maps for the three later years, solid lines indicate boundaries where territorial defense was witnessed, whereas borders inferred from movements of individuals and from the extent of blocs of arboreal vegetation are dotted.

Study of the maps reveals a remarkable stability of the areas occupied over the six-year period. From 1947 to 1948 (fig. 1) relatively few changes in configuration occurred. These were: (1) the addition of territory 9 to the west of 1 and 2 of 1947 (no pair was known to remain for nesting in this territory in the six years of observation); (2) the shrinkage and disappearance of territory 1 following the death of the male in January, 1948; and (3) the addition of territory 16 (between 2 and 7 of 1947), held by an unmated male. The territories were not mapped in 1949, but the outlines in 1950 did not

differ appreciably from the pattern in 1947 and 1948 (fig. 2). In 1951, two additional territories appeared, 46 (hitherto unoccupied) and 47 (comparable to 16 of 1948). These persisted in 1952 and, in addition, the transitory territory 58 and the area held by the unmated male X were occupied. Further, a pair of Chestnut-backed Chickadees (*Parus rufescens*) nested along a tributary north of territory 52. Even though the number of territories increased from six in 1950 (discounting 39) to nine in 1952 (discounting X), six territories held a fairly constant relationship throughout the six-year period. These were numbers 50, 51, 52, 53, 54, and 55 of figure 3.

Characteristics of boundaries.—Although no major realignment of territories was witnessed, a question arises concerning the degree to which boundary changes occurred. Before making this inquiry, we should determine the features of the habitat to which an individual titmouse responds in establishing a boundary. In this connection the terms

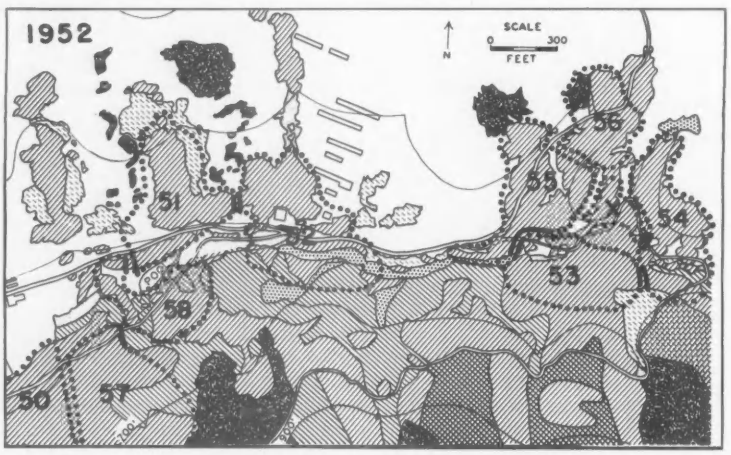

Fig. 3. Maps of territories of Plain Titmice in Strawberry Canyon as of May 15, 1952. Solid lines indicate those boundaries where defense actually was observed.

"neutral margin" (not adjoining another territory) and "defended margin" introduced by Southern and Morley (1950) may be useful. The margins of woodland usually serve as neutral, more or less permanent boundaries for these birds. As Lack (1940:307) found for the Robin (*Erithacus rubecula*) in Britain, roadways do not seem to act as barriers. However, a more extensive clearing of some riparian trees in the construction of a culvert in 1951 apparently resulted in the abandonment of the part of territory 41 south of that clearing. The area south of the culvert was occupied as territory 58 for a brief period during the following year.

Where the canopy is unbroken, a conspicuous branch or a shrub in a lower stratum may be used as a singing perch and hence becomes a boundary feature, an objective to be captured in an attempt at expansion. Parts of the boundaries between territories 1 and 2 (1947) and between 33 and 34 (1950) were of this sort. These points may be likened to the "preferred stations" about which the Great Tit (*Parus major*) is said to concentrate its activities in early spring (Hinde, 1952:50).

From the foregoing discussion it appears that characteristics and distribution of vegetation play an important role in the determination of many of the neutral territorial

boundaries of the Plain Titmouse. Of course, the boundaries must enclose an area of sufficient size to serve the needs of a pair of titmice. Although an average for 11 territories was calculated as 5.7 acres (Dixon, 1954:121), two and one-half acres probably would be close to an absolute minimum size.

The groves in the tributary gullies on the south-facing slope of Strawberry Canyon are essentially natural units of occupancy for titmice since they are partly-isolated blocs of arboreal vegetation of suitable size. If all the individuals in the canyon had been removed and repopulation allowed to take place, as in the population-removal census of Stewart and Aldrich (1951), some of these areas would have been occupied with essentially the same boundaries in effect, just as those authors found to be the case in some passerine species in coniferous forests in Maine. Other territories in the eastern part of the study area, where the woodland is more or less continuous, might have been arranged somewhat differently.

Minor shifts in boundaries.—Those edges of the territory which do not coincide with discontinuities of the canopy are as a rule more subject to alteration. The changes in the boundaries of a succession of territories held by M5, a male paired with a different female in each of four seasons, may indicate the usual condition of slight shifts in the margins of Plain Titmouse territories. Only about one-fourth of the margin of this male's territory bordered unwooded terrain. In 1948 the territory of M5 was expanded approximately 20 yards to the westward across a narrow glade to include the next row of trees. This encroachment on the territory of M6 apparently was made because the nest site chosen by M5's mate in 1948, a first-year female, lay very close to the western edge of the territory as it had existed in 1947 (fig. 1). By 1950, the western boundary (territory 34) had reverted to the condition of 1947, and the nest was situated on the south bank of the creek in an area not used by M5 in 1947 or 1948. Data for May, 1950, indicate a smaller territory for this male than was the case in earlier years, but this condition may have resulted from the fact that evaluation of boundaries in 1950 was made while incubation was in progress. Changes in outline of this territory appear to have been due in considerable measure to choices of nest sites by the several females.

Territorial boundaries of the Marsh Tit (*Parus palustris*), a chickadee-like species studied in England by Southern and Morley (1950:38–39), appear to have fluctuated more over a six-year period than those of the Plain Titmouse reported here. These authors attributed change in size of territory to the individuality of the owner, and they stated that older residents tended to hold larger territories than did younger birds. The only situation encountered in this study that suggested this factor of individuality occurred in territory 3, where the newly-established male M12 expanded the western portion of his territory during the late fall of 1947. This was accomplished along the margin of territory 1 defended by M1 in the spring of 1947. In March, 1948, this pair, now designated as territory 12, expanded the neutral southern boundary farther to the south than had their predecessors. Their expansion to the westward was prevented by the occupants of territory 11. This was the only instance when an attempt to enlarge holdings was noted. Such expansion by an inexperienced first-year bird may exceed the limits of area which can be defended successfully. The loss of part of the 12.5-acre domain of M1 in the fall of 1947 (fig. 1) may be explained in part on this basis. In no case, however, was an increase in size of territory with advance in age observed.

In addition to the influence of vegetational distribution, carry-over of breeding individuals from one season to the next may have an influence on the stability of territorial boundaries. The data on survival (see beyond) indicate that most of the adult titmice of this study existed on the area for more than one season. Thus, constancy of boundary would be promoted, since they are defended to some extent throughout the year.

Observance of boundaries.—The effects of continued occupation of an area by the same pairs may be evaluated in the light of the behavior of the birds with respect to boundaries. Unfortunately we can refer to no instance in which both members of two adjoining pairs were eliminated from the population simultaneously. However, some instances involving the disappearance of one pair are informative. The boundary between territories 11 and 12 (= 2 and 3, 1947, fig. 1) provides an example. The established pair which had occupied territory 2 in 1947 did not expand its eastern limits at the expense of the newcomer, M12, which had replaced the male of territory 3 during the fall of 1947. Moreover, his mate, F12, could not have known the boundaries from

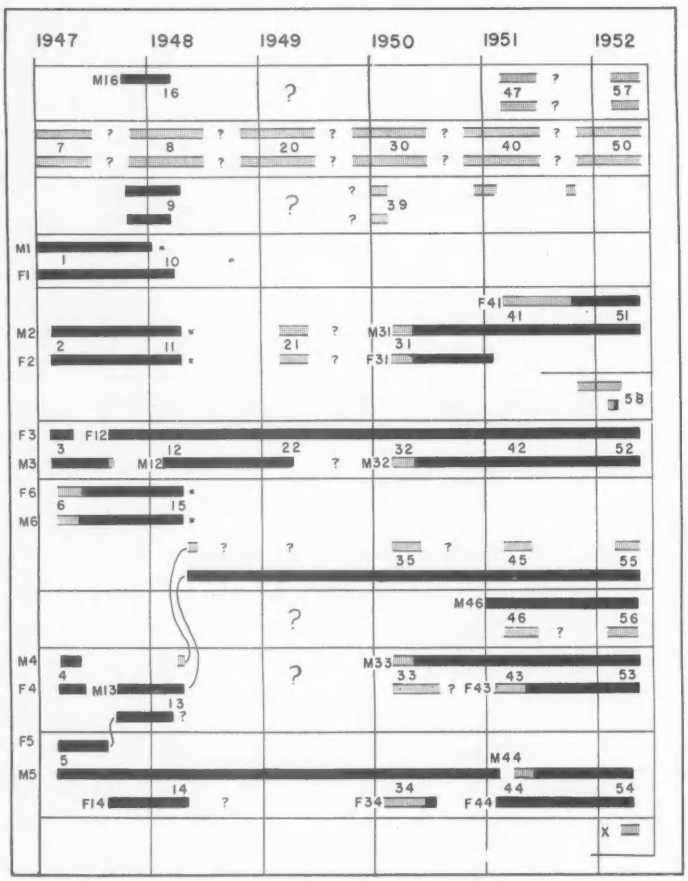

Fig. 4. Occupancy of territories by Plain Titmice, 1947–1952. Black bars indicate span of dates of tenancy of a banded individual; stippled bars, unidentified individuals. Horizontal columns represent territories shown on maps (figs. 1, 2, and 3). An asterisk indicates apparent or known removal of an individual by human agency.

the previous breeding season since she was a first-year bird. Thus she probably was not responsible for the maintenance of the boundary.

The pair of the neighboring territory (11) disappeared in April, 1948 (fig. 4). In one contest observed in April, 1949, it was evident that the pair which had occupied territory 12 in 1948 had not extended its western border at the expense of the newly-established pair. There was no natural feature to mark the boundary, which was located along a constricted "waist" of woodland connecting two more extensive tracts (fig. 1). Even though only the female of the eastern pair survived after the 1949 nesting season, the boundary remained virtually unchanged for the next three years, fluctuating over a range of not more than 20 yards. (Survival in the western pair, 21, cannot be assessed since the birds were unbanded in 1949.)

Similarly, the defended margins of territory 44 do not appear to have been altered following the disappearance of M5 early in 1951, nor did M6 enlarge his domain when territory 4 was vacated in May, 1947. Actually, trespass seldom was observed, and only one titmouse was trapped more than a few yards outside its territory. Repeated trespassing would be expected to result in learning of bait stations, and in repeated retrapping. This was known to have happened only in the case of the trespass of adjacent territories by M13 in May and June of 1950 and 1951.

Apparently the surviving pairs respect the borders as they have been established and the replacements learn them by contacts with their neighbors. Replacement following the loss of the pair of territory 12 probably occurred in the summer of 1948. Thus the gap was filled well before the period of maximum territorial response in spring. Even during that period there seems to be no pronounced tendency of Plain Titmice toward expansion of defended margins in the absence of neighbors. The opposite tendency was found in British Robins by Lack (1946:40). He stated that "when the owner of a territory disappears, the owners of the neighboring territories expand into the vacant site almost at once, and often the ground is fully occupied within twenty-four hours."

Since, in the Plain Titmouse population studied, the gaps created by the disappearance of a pair were not filled in by surrounding pairs, the survival of individuals "respecting" the boundaries would result in the maintenance of the system of population organization which was in effect. Since carry-over is considerable (see beyond), fluctuation in number of breeding pairs from one season to the next would be minimized.

As was indicated earlier, six "basic" territories remained in fairly constant relationship throughout the six breeding seasons. The increase in total population in Strawberry Canyon was achieved by the establishment of additional pairs in the previously unoccupied territories 46 and 47. Thus, the increase was effected by the occupation of greater area, the density in terms of acres per bird remaining about the same. From this observation, we might infer that territorial behavior would impose the upper limit of population density, which apparently was approached in 1952. This same conclusion was reached by Kluyver and Tinbergen (1953:283) in their study of the Great Tit in The Netherlands and it stands in contradiction to the contention of Lack (1946; 1954) that territoriality does not limit population density.

THE NATURE OF TERRITORIAL BEHAVIOR

During the latter part of the summer, when adult titmice are molting, their territorial activities are oriented principally toward the repelling of invading immature titmice. Singing is infrequent and there is no extensive patrolling of boundaries. During the period from August 3 through August 23, 1947, I spent a total of 35 hours in the field on 12 different days. The only times singing was heard were when an "owner"

encountered an intruder trapped on his territory (M6 versus M13, see beyond), and on one occasion following the release of an immature male from a trap. There are few contacts with neighboring pairs at this season. This territorial behavior differs from that observed in spring, which presumably is reinforced by events of the breeding cycle.

The aggressive aspect of territoriality in summer was indicated to me by several incidents including the defense of territory 6 against an intruding pair, the immature male M13 and his unidentified mate (see Dixon, 1949:117). M13 invaded the southwestern portion of M6's territory repeatedly in mid-August, 1947, being trapped there twice in three days of trapping in the period from August 17 to 21. He eventually settled in the area adjacent to the south, successfully incorporating the southwestern portion of M6's holdings into his own. Late in April, 1948, when M6 and F6 disappeared (fig. 4), M13 abandoned his own territory to claim that vacated by M6. However, M13 continued to defend the area won from M6 previously, holding it successfully for at least the next four years.

The active struggle for space recounted above differs from the passive aspects of territoriality discussed by Kluyver and Tinbergen (1953:279) and stressed by Lack (1954:270). These authors cited avoidance of those areas already settled by individuals of the species as important in determining population densities. Lack (*loc. cit.*) stated that "the retreat of the new-comer is the major factor concerned" in territorial behavior. Likewise, Lehmann (1953:235), working with Bobwhite Quail (*Colinus virginianus*) in southern Texas, reported that there were certain population density levels (both breeding and winter) above which habitat improvement measures could not effect further increase. These limits were attributed to an aversion to crowding.

The authors cited above were discussing a facet of territorial behavior manifested chiefly in spring. As pointed out by Kluyver and Tinbergen (for *Parus major* at that season), the less attractive habitats are accepted when the preferred ones are filled. This same phenomenon is witnessed among juveniles of *Parus inornatus* in summer and autumn as well. Both the defense by adults in summer and what may be termed "saturation avoidance" are inconspicuous and may pass unnoticed as the majority of juveniles (some of them paired) unobtrusively seek unoccupied areas. Only the more tenacious ones, such as M13, attract notice in summer.

Even in spring, mateless, first-year titmice apparently keep drifting until they find a vacancy in the population. Evidence that shifting of residence occurs among first-year birds as the breeding season approaches is provided by the abandonment of the transitory territories 9, 39, and 16, and by the replacement of deceased mates (by M44 and F41 and by the unbanded mate of M13 in 1948; see fig. 4). These movements were by individual birds, whereas at least some of the immatures seek territories in autumn as pairs (Dixon, 1949:120). At any season these wandering titmice encounter an intolerance which was found to be manifest by Chestnut-backed Chickadees as well (Dixon, 1954), in the latter case chiefly because of similarities in voice.

In spring, territorial "defense" appears to be more active than at other seasons. There is much patrolling of boundaries and formalized "clashing" with the established members of the population, the occupants of neighboring territories. The boundaries usually are changed but little as a result of these meetings, but the contests are prolonged and recur frequently, presumably because the opponents do not retreat, as an intruder which lacked a territory might be expected to do. This "defense" behavior of the Plain Titmouse is strikingly like that of the Wren-tit (*Chamaea fasciata*), a permanently-territorial inhabitant of Californian chaparral studied by Erickson (1938:263), who stated that "the general impression was not of birds continuously exerting pressure or sparring for an opening, but rather of their acceptance of the existing status."

Evidently, defense of area is not the sole function of these disputes in spring, and the application of the term "reproductive fighting" (Hinde, 1952:71) seems justified as an indication of the reinforcement of the normal tendency to defend the borders of the territories. To some extent these sham battles appear to provide social stimulation, as suggested by Darling (1952:190). Such behavior differs from the defense reaction against intruders at other times of the year and may be considered more of a ritual. This hypothesis is supported by the continued observance of boundaries by titmice rather than expansion following the disappearance of neighbors. The actual repelling of potential invaders of the territory in summer certainly is more important from the standpoint of determination of the population level. This defense of areas which have proven suitable for the needs of reproduction is effected by the established adults which clearly control the social organization of the population.

SURVIVAL AND REPLACEMENT

The extent to which the established individuals tend to maintain the spatial organization of the Plain Titmouse population may be judged from their survival and rate of replacement. Only six individuals were extant on the study area following the disappearance of four adults (apparently removed by target shooters) in April, 1948. Five of the remaining adults were already banded and four (F12, M12, M13, and M5) were known to be alive during the breeding season of 1949, occupying three territories (fig. 4). In 1950, three of the individuals, representing the same three territories (32, 35, 34) were still alive. As noted previously, the boundaries in 1950 did not differ markedly from those in 1948. In the breeding population of 1952, six territories were inhabited by at least one color-banded titmouse; in four of the six, one member of the pair was holding forth for at least its third season, while in each of the other two, at least one member of the pair was two years of age. In two of the territories, one occupant was nesting for the fifth season. The figures cited are based only on those individuals which were banded. If they are representative of the total population, they indicate a slow replacement rate for established adults.

For three of the years of this study it is possible to determine survival of banded adults of the previous year's breeding population. The numbers of individuals surviving were as follows:

1947 to 1948, 7 of 11 (excluding M1, killed accidentally in trap, January 11, 1948)
1950 to 1951, 5 of 8
1951 to 1952, 10 of 10

The total of 22 of 29 individuals persisting to breed the next year suggests an annual replacement rate of about 25 per cent.

Some additional computations can be made from the published data of Price's (1936) study of this species at Stanford University, California, from 1928 through 1933. His recovery records of adults were obtained only by retrapping in nesting boxes. Hence those pairs which chose natural cavities rather than nesting boxes for renesting would be lost from the record, although such disappearances did not necessarily indicate death. This assumption was supported by the fact that nest boxes deserted the season after being occupied were not appropriated by other pairs of titmice.

Although Price reported recovery of only 53 and 50 per cent of the 28 and 40 adults captured in 1931 and 1932, respectively, study of a table of mating relationships (*op. cit.*:26) suggests a higher survival rate. This table indicated pairing relationships of 38 individuals in what appear to be 14 territories. Of 20 adult titmice present in 1931, 16 (80 per cent) are known to have been present in 1932. In 1933, 19 (73 per cent) of the 26 birds trapped in 1932 renested in these "territories." Furthermore, the consideration

of the 38 individuals as a group shows that 27 (71 per cent) renested at least once, and 11 (28.8 per cent) renested for three or more seasons. A combination of Price's data (from a sample larger than the Strawberry Canyon population) and mine demonstrates the renesting of 57 of 75 established adults, a carry-over of 76 per cent from one breeding season to the next.

The data presented by Lack (1954:91–93) show a rather different picture of longevity for a selected group of passerine species. He reported annual adult mortality in passerines to vary from 41 to 72 per cent, and "average expectation of further life of adult" correspondingly from 1.9 to 0.9 years. Many of Lack's calculations of annual adult mortality are from age at death in a sample of banded birds; my records of Plain Titmice do not permit calculation by that method. If we accept for the present the value of 76 per cent annual adult carry-over, adult mortality in the Plain Titmouse would be 24 per cent each year. Using this figure in computing the average expectation of further life from the formula $\frac{2 - m}{2m}$, where m equals percentage annual mortality (Lack, 1954:93), we obtain a value of 3.5 years. Even an apparently conservative estimate of 66 per cent survival yields a value of 2.5 years. This expectation of further life in adults of *Parus inornatus* is markedly higher than that for other passerines cited by Lack (*loc. cit.*). However, it resembles that of the sedentary, permanently-territorial Wren-tit, for which Erickson (1938:309), using the formula devised by Burkitt, calculated the "average age attained by birds that survive their first breeding season" to be 4.43 years. By way of corroboration she stated that 61 per cent of the breeding population in 1933 were three years old or older, although in a declining population adult mortality for the year amounted to 36 per cent (*op. cit.*:310). Mean longevity of Wren-tits as of March 1 was recalculated from Erickson's data as "about 3 years" by Farner (1949:73). He expressed a view that even the 2.3 years mean longevity suggested by the 36 per cent adult mortality of Erickson's sample for 1933 ascribed "an unusual longevity to such small birds."

A behavior trait shared by the Wren-tit and the Plain Titmouse is year-around territoriality. In both of these species the holding of a territory seems to confer on the established individual a decided advantage in survival. To a considerable extent this may be due to food supply. Erickson (*op. cit.*:313) presented evidence that the established individuals had a lower rate of disappearance than did the immature or non-territorial Wren-tits during the period of food shortage (November through January).

A second value of the territorial habit, the "place-conditioned dominance" (Nice, 1943:168) of the individual or pair situated in familiar surroundings, must be considered. A similar advantage might obtain among sedentary (but not necessarily territorial) individuals of other passerine species. Even though Linsdale (1949:94) noted no pronounced differences in survival between migratory and sedentary species retrapped in winter in California, inspection of his table 2 suggests a different relationship. Precise computations are not possible from his published data, but the percentage of individuals of the ground-foraging towhee species (*Pipilo fuscus* and *P. erythrophthalmus*) retrapped the fourth year is almost twice that for the migratory White-crowned Sparrow (*Zonotrichia leucophrys*).

Third, there may be a social advantage to the permanent pairing relationship. In the Wren-tit, Erickson reported (*op. cit.*:266) that "when a pair was broken up, one or both members of it disappeared entirely." Widowed males tended to remain on their territories, whereas bereft females appeared more prone to shift territory to seek a new mate. Hence, the latter probably were exposed to greater hazards in unfamiliar surroundings.

The tendency to abandon the territory did not appear so prevalent in the Plain Titmice studied, even among females. For example, before her disappearance early in 1948, the widowed female F1 remained for six weeks on the territory where she had nested the previous year. At least two other widowed female titmice (F12 twice, F44) were known to have remained in the same territory and remated, and no widowed female is known to have nested in a different location. Although these data are far from adequate, they do point to a slow rate of replacement of the established adults as a population characteristic of coastal Californian Plain Titmice.

Further evidence for the low mortality rate in adults of the Plain Titmouse and Wren-tit may be found in their reproductive rates, which are reduced correspondingly. A direct relationship of this sort was demonstrated by D. W. Snow (cited by Lack, 1954:105) for three populations of the Blue Tit (*Parus caeruleus*). Snow found a clutch size of 11.6 eggs characteristic of British populations, which had an annual adult mortality of 73 per cent, calculated on the basis of the ratio of adult to first-year specimens. At the other extreme, in the Canary Islands, adult mortality was 36 per cent and clutch size, 4.3. The Great Tit in Holland was reported as averaging 9 eggs per clutch and having an adult mortality of 49 per cent per year. Erickson (*op. cit.*:288) found that 24 Wren-tit clutches averaged 3.9 eggs, whereas the average for 62 Plain Titmouse sets was found to be 6.75 (Price, 1936:24). Judging from the mortality rates in other titmice, the 6- or 7-egg clutch indicates a mortality rate closer to 40 per cent than to the 24 per cent calculated for *inornatus*.

The Wren-tit could potentially produce two young per adult, the Plain Titmouse, three. Neither species rears a second brood as a rule. However, the tendency to renest following destruction of the first nest does not appear to be strong in the Plain Titmouse. A strong renesting tendency in *Chamaea* (Erickson, *op. cit.*:282) may counteract the smaller clutch size, for the increment to the population as a result of reproduction results in an approximate doubling in both species.

Data supporting the contention made for the Plain Titmouse come from brood counts that are admittedly meager. My counts of 13 broods averaged 5.0 fledglings per family. This figure may be low due to difficulty in accounting for all fledglings. Applying this average to the Strawberry Canyon population for three separate seasons yields the following totals:

Year	Breeding adults at fledging time	Broods	Totals Fledglings	Young plus adults
1947	14	5	25	25 + 14 = 39
1950	12	5	25	25 + 12 = 37
1951	16	?6	?30	?30 + 16 = 46
			Ratio of totals	80: 42

In 1947 and in 1950, no brood was produced in territory 2 (= 32), so on a population basis, approximately two offspring are fledged per adult present. On an average, according to the data on rate of replacement of adults, only one of the four offspring produced per pair will survive to become a breeding bird the following spring.

DISPERSAL OF JUVENILES

The survival of established adult Plain Titmice and their territorial behavior contribute to a rigid population structure. The impact of this system strikes the juveniles soon after they achieve independence at a time of highest density of the population as a whole. In most of those passerine species which breed at one year of age, the individual is not confronted with the problem of establishment on a restricted area until the onset of the breeding season, at a time when the population density is thinned. In this respect

a Plain Titmouse's first year is compressed, at least in the populations inhabiting coastal California.

The population pressure is alleviated by the dispersal of the juveniles, which results in what Grinnell (1922:378) referred to as a "prodigal expenditure of individuals." Although Goodbody (1952) noted an "explosive" exodus of juvenal Great Tits and Blue Tits in mid-summer from the areas where they were fledged, he found 14 and 23 per cent, respectively, remaining on the 55-acre area in early September. A similar tendency toward lingering was noted among juvenal Plain Titmice in mid-August, 1947 (Dixon, 1949:128), although one juvenile is known to have left his parents' territory one month after fledging. Thus the dispersal is gradual, although none of the juveniles of *inornatus* was seen within its parents' territory by mid-summer.

The completeness of the emigration and the apparent high rate of juvenal mortality are indicated by the fact that so few juveniles ever were identified after they left the parental territories. Only four of the 35 juveniles banded while still associated with their parents on the study area in May or June in three seasons ever became members of the breeding population. These were M13, F14, F44, and M46. Two others (M14, discussed by Dixon, 1949:128, and F58) remained there but did not survive to nest. One male nested outside the area 550 yards from his birthplace; another (M16) settled unmated 800 yards from his birthplace, then abandoned his territory in March of his first year and was found dead 400 yards away when 22 months of age. These values correspond to those which Kluijver (1951:14) reported for the Great Tit in The Netherlands. He found that the majority of juveniles recovered had settled within 200 to 800 meters of their birthplaces. Price (1936:25) found only two of the 145 Plain Titmice banded as nestlings actually nesting in the area where they were reared.

This dispersal, almost certainly density-dependent, since its intensity would be increased at higher densities, is important to the species from three points of view: (*a*) pioneering, in the sense of Grinnell (1922), to test the suitability of terrain not currently inhabited by the species; (*b*) the provision of a constant but diminishing flow or pool of potential replacements for vacancies which may be created at any time of the year; and (*c*) dispersal of genetic traits through the population. This emigration would tend to be more pronounced and to cover greater distances during years of high survival of adults, or when the greater amount of the area was occupied, as in the locality of this study in 1952. Hence, as Miller (1947:187) has noted, the effect of dispersal of genetic traits (average number of territories crossed before settling) might differ considerably from one year to the next as a function of these several variables.

SUMMARY

Territorial boundaries in a population of Plain Titmice occupying a 144-acre canyon on the east side of San Francisco Bay were studied intermittently in a six-year period. The basic alignment of six occupied areas remained fairly constant throughout the six breeding seasons. This stability is attributed in part to distribution of blocs of woodland, but the tenancy of long-lived individuals is judged to have had a greater influence. Of considerable importance was the tendency toward maintenance of boundaries following disappearance of neighboring pairs rather than expansion to occupy the vacated areas.

Although most juveniles tend to avoid occupied areas in the period of summer dispersal, their intrusion is resisted actively by the established adults. At this time the established adults defend those areas which have proved suitable for occupation during the breeding season. Many of the territories on which juveniles settle in summer and autumn are abandoned as the breeding season approaches.

Patrolling of boundaries, exchange of song, and pursuit of neighbors along boundaries are conspicuous in late winter and in spring. This "defense" may serve largely to

raise the emotional level of adults in preparation for nesting, since expansion usually is not attempted.

Annual survival of about 75 per cent of the established individual Plain Titmice is indicated from the data on color-banded birds and from the band return data presented by Price. The renesting of 57 of 75 adults indicates an annual adult mortality of 24 per cent and an estimated further length of life of 3.5 years for those adults. These values are higher than those reported for most passerines, but they approach those for the Wren-tit, adults of which also defend a territory throughout the year. Correspondingly, reproductive rate is lowered and a direct causal relationship between adult survival and year-around territoriality by paired birds is inferred.

The dominance of the population by the established adults forces a density-dependent emigration of the juveniles soon after they achieve independence. This dispersal effects colonization of new areas, creates a "pool" of replacements, and contributes to gene flow.

The population of the study area experienced an increase from six to eight breeding pairs from 1950 to 1952; this was achieved through occupation of additional area, the population density in terms of acres per bird remaining essentially unchanged. This fact suggests that territorial behavior may impose an upper limit on population density.

LITERATURE CITED

Aiken, C. E. H., and Warren, E. R.
1914. Birds of El Paso County, Colorado. II. Colorado Coll. Publ., Sci. Ser., 12:497–603.

Darling, F. F.
1952. Social behavior and survival. Auk, 69:183–191.

Dixon, K. L.
1949. Behavior of the plain titmouse. Condor, 51:110–136.
1954. Some ecological relations of chickadees and titmice in central California. Condor, 56: 113–124.

Erickson, M. M.
1938. Territory, annual cycle, and numbers in a population of wren-tits (*Chamaea fasciata*). Univ. Calif. Publ. Zool., 42:247–334.

Farner, D. S.
1949. Age groups and longevity in the American robin: comments, further discussion, and certain revisions. Wilson Bull., 61:68–81.

Goodbody, I. M.
1952. The post-fledging dispersal of juvenile titmice. Brit. Birds, 45:279–285.

Grinnell, J.
1922. The role of the "accidental." Auk, 39:373–380.

Hinde, R. A.
1952. The behaviour of the great tit (*Parus major*) and some other related species (Leiden, E. J. Brill).

Kluijver, H. N.
1951. The population ecology of the great tit, *Parus m. major* L. Ardea, 39:1–135.

Kluyver, H. N., and Tinbergen, L.
1953. Territory and the regulation of density in titmice. Arch. Néerl. Zool., 10:265–289.

Lack, D.
1940. The behaviour of the robin. Population changes over four years. Ibis, 1940:299–324.
1946. The life of the robin. Revised ed. (London, H. F. and G. Witherby).
1954. The natural regulation of animal numbers (Oxford, Clarendon Press).

Lehmann, V. W.
1953. Bobwhite population fluctuations and vitamin A. Trans. N. Amer. Wildl. Conf., 18:199–246.

Linsdale, J. M.
1949. Survival in birds banded at the Hastings Reservation. Condor, 51:88–96.

Miller, A. H.
1947. Panmixia and population size with reference to birds. Evolution, 1:186–190.
Nice, M. M.
1943. Studies in the life history of the song sparrow. II. The behavior of the song sparrow and other passerines. Trans. Linn. Soc. New York, 6:i–vii + 1–328.
Price, J. B.
1936. The family relations of the plain titmouse. Condor, 38:23–28.
Southern, H. N., and Morley, A.
1950. Marsh-tit territories over six years. Brit. Birds, 43:33–47.
Stewart, R. E., and Aldrich, J. W.
1951. Removal and repopulation of breeding birds in a spruce-fir forest community. Auk, 68:471–482.
Woodbury, A. M., and Russell, H. N., Jr.
1945. Birds of the Navajo country. Bull. Univ. Utah, 35:1–160.

Department of Wildlife Management, Agricultural and Mechanical College of Texas, College Station, Texas, August 8, 1955.

A SEA-CAVE NEST OF THE BLACK SWIFT

By KEN LEGG

The first reported nest and egg of the Black Swift (*Nephoecetes niger*) was found on a damp cliff above the sea near Santa Cruz, California. In Vrooman's account (1901) the nest which held the egg was described as "a slight depression in the mud" just behind a tuft of grass. Since Vrooman's discovery there have been published accounts of other nests, all of which have been in the mountains, usually in damp situations near waterfalls. The nests, unlike the first nest, were well-shaped cups constructed of the pinnae of five-finger fern (Michael, 1927), moss (Smith, 1928; Thompson, *fide* Bent, 1940: 260; Hall, 1948; and Murphy, 1951), or resurrection-moss (Dixon, 1935).

In July, 1955, Emily Smith told me that there was a Black Swift egg in a seaweed nest in a sea cave near Santa Cruz. Knowing, through the late Clark Streator, that Black Swifts had nested in the cave, she visited it on July 7. As far as can be determined, this is the first record of a nest in such a situation. The location did, however, correspond in certain respects with other nest sites. It was dark, no sunlight ever reaching the nest, and it was constantly moist.

The nest in the sea cave was a thick-walled, compact, well-built saucer of live, green seaweed (*Enteromorpha* sp.), an abundant plant in the area, growing upon both horizontal and vertical rocks; this plant comprised about 90 per cent of the nest. In the center and making up about 8 per cent of the bulk was *Phyllospadix*, with *Porphyra naiadum* epiphytic on it. These are both marine plants, the former a flowering plant, the latter a red alga. Another red alga represented by a fragment was *Plocamium pacificum*. Two kinds of moss were also used in the nest and together comprised about 2 per cent of the bulk: *Porothamnium bigelovii* and *Brachythecium*(?). The former is described in bryological works as growing on moist shaded rocks, sometimes in the reach of salt spray. The nest had a "cushiony" appearance. No saliva was used.

The complete clutch, consisting of one egg, was present in the nest at 7:00 a.m. on July 7. When Miss Smith visited the cave at this time there was no incubating bird present. Outside, she saw two Black Swifts circle by the entrance several times and then fly out of sight. Soon afterward there were four swifts present, two engaging in courtship behavior, but it was not long before all four were gone, none having entered the cave. The swifts were not seen again in the course of an hour's watch. It is possible that incubation had not begun on the 7th.

On July 14 I visited the cave, and, as I entered, the incubating bird flushed from the nest. On July 21 the adult was reluctant to leave. On the 24th I led a group of twenty naturalists to the cave and we entered as a group. While I held a flashlight beam upon the bird, the group stood some ten feet away, and although we watched and talked for some time, the bird sat tight.

A visit to the cave on August 4 revealed a black-skinned, naked, helpless little swift sprawled in the bottom of the nest. No adult was seen. Murphy (1951:449) gives the incubation period as approximately 24 days. If incubation was begun on July 8, as is suspected, and the egg hatched on August 3, this would give an incubation period of 27 days in this case.

On August 18, at an age of approximately two weeks, the nestling was completely covered with heavy down, and unopened feathers were present only on the wings and tail. By August 25 it had short tail feathers and the wings were feathering out. The bird was banded on this date.

On September 1 the nestling appeared to be nearly full grown and was observed

preening itself and scratching its head with its foot. The young bird completely ignored my presence. On September 2, at an age of four weeks, I took the bird in hand to check the band. It clasped the nest lining with one claw to resist being lifted from the nest, and it attempted to bite my hand.

It had been suspected that at least one of the parent birds was roosting in the cave with the young. Just before midnight on September 10, James Beck and I visited the cave. The night was exceedingly dark and a heavy, low fog shrouded the coast.

Fig. 1. Sea cave in which Black Swift nest was located near Santa Cruz, California.

As we entered the cave, our light beams stabbing the darkness, an adult swift fluttered helplessly to the sand floor, then clung to my companion's trouser leg and remained there until he caught it. He deposited the bird on one of the low ledges, but it flopped down again, this time catching my trouser leg and pulling itself up nearly to my waist.

I took the bird in my hand, examining it carefully. The tail was spread and it was quite discernable that the tail feathers were pointed, much like those of a creeper. In contrast to the juvenile still on the nest, which had a silvery forehead, the head of this adult was brown. A size comparison was made and the adult was found to be noticeably smaller than the young. We extinguished the lights, and I placed the bird at arms-length back upon the highest ledge which I could reach. We then departed hastily into the darkness. Although this adult was completely confused in darkness, these birds apparently leave the nest site quite early if it is a moonlight night. On an earlier visit, on September 2, I was at the cave at 5:30 a.m. This was twenty minutes before any hint of dawn. The parent had departed. At 5:50, just as dawn was starting to show the first faint signs, the parent returned, presumably from a foraging trip. This particular morning, however, was an exceptional one. There was no fog; it was clear and warm, and a full moon was shining. Even as one stood in the darkened cave and looked toward the mouth, considerable light could be seen above the ocean.

At 6:00 p.m. on September 16 the young was still on the nest. On September 17 at 4:30 p.m. the fully developed young had left. Probably the bird was hatched on August 3. If so, it was in the nest for the long period of forty-four days, leaving sometime on the forty-fifth day.

Koskimies (1950) gives the nestling period for the European Swift as from forty to forty-three days and states that when the young leave the nest they are completely independent and probably start on migration immediately.

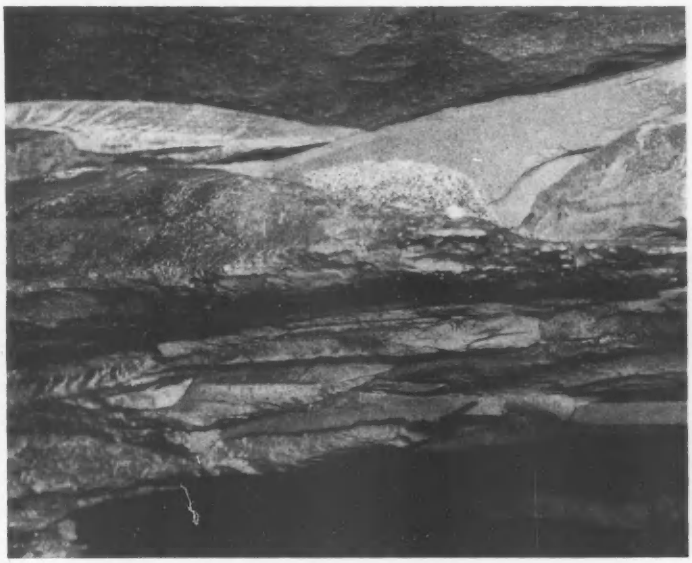

Fig. 2. Seaweed nest of Black Swift on shelf in sea cave.

We were interested in the heavy covering of down on this swift at two weeks of age. The down that the nestling swift acquired after hatching appeared as heavy as the natal down of a precocial bird. The young of the Chimney Swift (*Chaetura pelagica*) are without down (Bent, 1940:275), but we have no information on the other two North American swifts.

Although we cannot prove any adaptive value, it is interesting to speculate on the advantage of down to the Black Swift nestling. In the literature already cited the nest sites are described as dark, cool, and with one exception, damp. Smith and Michael both found that the young bird was alone in its chilly nest for long periods between feedings. Furthermore there is a possibility that the Black Swift undergoes torpidity at times.

Udvardy (1954) in his analysis of the summer movements of Black Swifts in relation to weather cites Koskimies' experimental study which proved that the nestling of the European Swift (*Micropus apus*) can survive starvation by reversible torpidity while its parents are away during the passage of a storm. Because the two swifts are closely related and have similar habits, as Udvardy points out, it is possible that the lone Black Swift nestling, in times of stormy weather, can wait for several days in a torpid state for the return of its parents. Under these chilly conditions a covering of

down would have its advantages. However, we saw no evidence of torpidity in the nestling and the adults apparently had regular and daily food schedules.

On August 18 insect remains were collected at the nest. The young ejected feces over the nest rim onto the sand below, but just outside the nest and on the nest rim were found fragments of insect remains. One of these bits of material had the form of a regurgitated pellet.

Examination revealed this to be a mass of ingested material. The bulk of it consisted

Fig. 3. Nestling Black Swift on September 2, 1955.

of portions of ants, pieces of the wing veins being found to establish this fact. In addition, the remains included one crane fly, one damsel fly, and five dipterous larvae (family Anthomyiidae).

Other insect remains found near the nest included remains of beetles and flies. Among recognizable ones were represented the beetle family Carabidae and fly families Chironomidae and Tipulidae.

Koskimies (1950) mentions "food balls" (insect masses) being brought to the young of European Swifts. The adults travel great distances and capture large quantities of insects which are carried in the throat during transport to the young. The material collected at the Black Swift nest, however, showed that it had been ingested. We can speculate that the Black Swift, like certain of the flycatchers, regurgitates indigestible insect parts.

Acknowledgements.—I am especially grateful to Emily Smith for bringing the swift's nest to my attention, aiding in the observations, and for assisting with the manuscript. I wish to thank the Scaroni family for its many services, and for the understanding and patience exhibited throughout the many trips to its ranch. Dr. L. R. Blinks of the Hopkins Marine Station, and Dr. G. F. Papenfuss and Miss Shirley Sparling of the Department of Botany, University of California, identified the plants used in the nest. Dr.

Frank A. Pitelka gave valuable suggestions regarding the handling of the investigation and Dr. Paul D. Hurd identified the insect remains from collected material.

SUMMARY

A Black Swift nest constructed of fresh green seaweed and containing one egg was found in a sea cave. An approximate incubation period of 27 days and a nestling period of 45 days were recorded. The nestling, at the age of two weeks, was heavily down-covered. Insect remains collected at the nest consisted mainly of ants, but one crane fly, one damsel fly, and five dipterous larvae were identified.

LITERATURE CITED

Bent, A. C.
1940. Life histories of North American cuckoos, goatsuckers, hummingbirds and their allies. U. S. Nat. Mus. Bull. 176.

Dixon, J. S.
1935. Nesting of the black swift in Sequoia National Park. Condor, 37:265–267.

Hall, E. M.
1948. Black swift nesting in southern California. Condor, 50:274.

Koskimies, J.
1950. The life of the swift, *Micropus apus* (L.), in relation to the weather (Kirjapaino O. Y. Sana, Helsinki).

Michael, C. W.
1927. Black swifts nesting in Yosemite National Park. Condor, 29:89–97.

Michael, E.
1933. A young black swift. Condor, 35:30.

Murphy, J. A., Jr.
1951. The nesting of the black swift. Natural History, 60:446–449.

Smith, E.
1928. Black swifts nesting behind a waterfall. Condor, 30:136–138.

Udvardy, M. D. F.
1954. Summer movements of black swifts in relation to weather conditions. Condor, 56:261–267.

Vrooman, A. G.
1901. Discovery of the egg of the black swift (*Cypseloides niger borealis*). Auk, 18:394–395.

Prairie Creek State Park, Orick, California, December 5, 1955.

LIFE HISTORY OF THE RUDDY GROUND DOVE

By ALEXANDER F. SKUTCH

The Ruddy Ground Dove, also called the Talpacoti Ground Dove (*Columbigallina talpacoti*), a species hardly larger than a sparrow, is found from southern México through much of Central and South America to eastern Perú and northern Argentina. The male has a grayish head, cinnamon-brown upper plumage, warm reddish-chestnut wings with two black bars on the coverts, and russet-vinaceous under parts. The female is paler, more grayish and brown, with usually only a faint wash of the male's ruddy color on her breast and wings. The eyes of both sexes, when viewed in a strong light, are red; those of the male are a deeper red than those of the female, but in the shade the irides of both appear black. Their bills are light horn-color with a darker tip; their feet are reddish-pink.

In Central America these doves are found on both coasts and range upward into the foothills to an altitude of about 3500 feet. They thrive best among the vegetation of the cultivated lands in regions of abundant rainfall that were formerly covered by heavy forest. They are numerous throughout the Caribbean lowlands wherever the forest has been destroyed, in the southern and central parts of the Pacific slope and lowlands of Costa Rica, and amid the coffee plantations on the lower Pacific slope of Guatemala. In somewhat more arid regions, as about the head of the Gulf of Nicoya, they mingle with the Common Ground Dove (*Columbigallina passerina*), but they do not follow it into still drier areas where cacti are more numerous, nor do they extend half as far above sea level as this hardier and more adaptable congener. However, in the regions of heavy rain-forest where the Ruddy Ground Dove is most abundant, the Common Ground Dove is absent.

The Ruddy Ground Dove dwells among the cultivated lands and pastures, and it is found in the weedy vegetation on neglected fields until this growth becomes high enough to exclude the sunshine from the ground. I have never seen it in the forest. It likes best to forage on bare and open ground, especially in the vicinity of human dwellings and cowsheds, where ten or twenty may gather in a flock, sometimes in company with Blue Ground Doves (*Claravis pretiosa*). What they so industriously gather from the bare earth is difficult to determine, but probably they pick up small seeds and insects.

The call of the Ruddy Ground Dove is a soft *kitty-woo*, uttered by both sexes. This dove also delivers a simple, low *coo*, and I have heard the male give a phrase which may be written *too-oo-woo*. The voice of the male is slightly deeper and fuller than that of the female. One female while brooding nestlings called *t'cuwu, t'cuwu*.

SLEEPING

In the village of Buenos Aires in southern Costa Rica, one December, I found a number of Ruddy Ground Doves roosting amid the bases of the broad, crowded leaves of the arborescent *Dracaena fragrans* that bordered the pathway leading up to a little church. Here they slept in company with many wintering Baltimore Orioles (*Icterus galbula*). The male of a pair, which built a nest in a dense hedge of *Stachytarpheta* behind our house, slept in the hedge not far from the nest where his mate incubated. Another male roosted for several nights amid the dense foliage of a sour orange tree, about 20 feet from his nest which was in a calabash tree. He did not sleep with his head turned back and buried in the plumage of his shoulders, in the manner of many birds, but held it forward and exposed, the bill pointing slightly downward. This is the usual sleeping posture of the ground doves.

ATTACHMENT OF MATES

Mated Ruddy Ground Doves are strongly attached to each other. One May morning in southern Costa Rica, I watched a male and a female that were perched side by side in a small tree growing in a mountain pasture. These birds were pressed so closely together that the female held up her wing on the side next to her mate, as though there was not space for it between them. Presently they began to preen, and the female gently billed the feathers of her partner's neck. After a time they both turned to face in the other direction and pressed as closely together as before, but with different sides in contact. They remained resting side by side in this fashion for nearly an hour.

THE NEST

Nest-site.—In Colombia, the Ruddy Ground Dove begins to build its nest in December for, on January 3, 1941, I found a nest with two eggs near Cali in the Cauca Valley. In southern Costa Rica and in adjacent parts of Panamá, the long breeding season starts off at least as early as January. The nest is usually placed in a tree, shrub, or herb, growing in a low thicket, bushy field, pasture, plantation, dooryard, or hedgerow. In western Panamá I found nests built upon the topmost "hands" of bunches of green bananas hanging in a plantation; here the upturned fruits kept the nests in place. Occasionally the slight structure rests upon the abandoned nest of some other bird. One pair used as their foundation the remains of an old nest of the Blue Tanager (*Thraupis episcopus*) which was in an orange tree; a second pair built upon a nest of the Golden-masked Tanager (*Tangara nigro-cincta*); and a third pair placed their nest on top of the bulky edifice of sticks made by the Slaty Castle-builder (*Synallaxis brachyura*). An exceptional site was a leaf of a pineapple plant, one of a dense cluster growing close beside our house. Here the nest was in an exposed position, with no foliage above to shade it from the morning sun, and little to screen it at the sides. Thirty nests that I have found ranged from one to about 30 feet in height, but nests which are lower than two or higher than 20 feet are exceptional. Two-thirds of the nests were from four to eight feet above the ground. Although the related Common Ground Dove and the Plain-breasted Ground Dove (*Columbigallina minuta*) sometimes build upon the ground, the Ruddy Ground Dove appears never to do so either in the Guianas (Haverschmidt, 1953:22), Panamá, Costa Rica, or Guatemala.

Nest-building.—The shallow, saucer-like nest is built by male and female working in closest coöperation. On January 3, 1941, I discovered a pair building a nest about 20 feet above the ground in a crotch of a jacaranda tree growing in a vacant lot. This tree was near a motion-picture theater on the outskirts of Cali, Colombia, where this dove was exceedingly abundant. The female was sitting in the nest, arranging the materials. Her mate picked up straws from the ground, then flew up to the nest and stood on her back while he laid them beside her. After he had done this three times the female flew away; then the male sat on the nest himself, arranging the sticks and straws with his bill. Presently he, too, left and the pair did not return for some time.

This method of building, with one member of the pair sitting upon the incipient nest and the other bringing material to it, is widespread among pigeons. The Blue Ground Dove, the Red-billed Pigeon (*Columba flavirostris*), the Short-billed Pigeon (*C. nigrirostris*), the White-tipped Dove (*Leptotila verreauxi*) and other species construct their nests in the same fashion. Whenever it is possible to distinguish the sexes, it is the male who brings most or all of the materials while the female sits on the nest and arranges them in the structure.

At about seven o'clock in the morning of June 13, 1943, I discovered a pair of Ruddy Ground Doves building a nest in an annatto tree (*Bixa orellana*) growing close beside

my house in the valley of El General, Costa Rica. The site was six and one-half feet above the ground, on a thick branch of the tree. The nest was just newly begun, with only a small accumulation of straws and the like in a crotch. About two feet away, nearer the center of the tree and slightly higher, was a still smaller collection of straws, evidently another beginning of a nest. The surrounding foliage was open, so that I enjoyed an unusually favorable view.

Although the female dove was absent when I began to watch, the male twice brought material and sat on the nest to arrange it. The female then returned and took her position on the nest. The male came twice more with one straw each time and stood on the female's back while he laid it in front of her; when she was present, he always stood upon her to deposit the material. After he flew off, she put the straws and twiglets in order. However, after receiving the second piece she left, probably frightened by a movement I had made. The male then brought two more straws, one at a time, and arranged them himself. Then his mate returned and sat while he carried seven straws to her; after placing the last of these she flew away, apparently because she was bored.

When next the male returned with a bit of nest material, instead of going to the position where the pair had been building, he went to the other accumulation of material nearer the center of the tree. Here he deposited his burden and settled down to shape the nest. Soon the female, returning with empty bill, saw the male there and went directly to sit on him, until he moved off the incipient nest and left her resting there alone. After a short absence, he again returned with a straw, but he ignored his mate sitting on the second nest and went directly to the first structure where he placed his straw and settled down to shape the nest. Here he remained until the female deserted the inner position and came to him, sitting half upon him until he made way for her. Here she stayed, putting things in order, while he brought her three more straws. Her willingness to go ahead with building in whichever of the two locations her mate fancied, suggested that the choice of the nest-site rested with him. Continued watching made it clear that he took the initiative in nest-building and his mate followed his lead.

Later the female flew away and the male brought two more straws and sat on the nest while he worked them into place. Then, from 8:30 to 8:51 a.m., both members of the pair were absent and no work was done. At the latter hour the male came, followed by his mate. I could not see whether he carried anything in his bill, but she clearly brought nothing. He preceded her to the nest and sat upon it, twitching his wings. Soon she came and stood beside him until he relinquished his position to her. He flew off, but in a few minutes returned with material to lay in front of her. He brought four pieces; and then she, quickly losing interest as usual, walked from the nest and out along the supporting branch, at 9:05. While she rested there, preening, the male came with still another contribution and sat in the nest to work it into place. At 9:10 the female flew from the annatto tree and the male rose from the nest to follow her. Although I watched until ten o'clock, no further work was done; nor did I see the doves at their nest later in the day.

On the following morning, before sunrise, I began to watch the nest from a blind which I had previously set in a favorable position. Neither member of the pair appeared in the annatto tree until well after sunrise, at 6:44, when the male came alone and settled in the nest to arrange its materials, pausing once in his work to call *kitty woo, kitty woo, kitty woo.* Three minutes after his arrival the female appeared, as usual bringing nothing in her bill. She walked over the male on the nest, then stood beside him, reaching over his back to arrange the material on the opposite side. Then she walked over him again, but he would not yield his position on the nest to her, and after a minute she flew away. A few minutes later he also left.

At 7:09 a.m. the pair returned together, both with empty bills. The male went first to sit on the nest, and his mate came and stood upon him; then she stood at his side. After a minute or two he flew off and she settled into his place. During the next 19 minutes the male brought six contributions, including straws and rootlets, which as before were deposited while he stood on his partner's back; these, the female shuffled into place with her bill. The pair made a pretty picture in the old annatto tree, which had been cut back in successive harvests of the fruits until it had a shapely, rounded dome of light green foliage, that at this season was covered over with blossoms of a delicate pink and prickly developing pods of a light shade of red, all aglow in the golden beams of early morning sunlight.

At 7:30 a.m. the male dove vanished and remained away for nearly 40 minutes. During his long absence the female sat constantly on the nest, at first keeping herself well occupied with the task of shuffling its straws into a more compact mass, later merely resting quietly, preening a little or pushing the materials about in a desultory way. When at last her partner returned, his bill was empty, but he stood beside her and went through the motions of placing a straw by her breast. Then he dropped down to the lawn beneath the tree and returned promptly with a contribution. He now began to bring things to his mate in rapid succession, for he had found a liberal supply of straws and grass rootlets, and during the next quarter-hour he took ten pieces to the nest. Among his contributions were fine fibers and one brown, curled annatto leaf, which was accepted and worked into the structure by the female, although it resembled nothing else there. Although on each trip to the nest he carried only his usual single piece, he carefully selected this from the available supply, picking up and dropping again many articles which proved unsatisfactory. Most other birds would have carried more of a "lazy man's load" of several pieces each time and so have economized effort.

After 8:23 a.m., five minutes passed before the male dove made another visit to the nest, this time bringing a fine straw. Then he rested for ten minutes, at the end of which time he embarked upon another period of concentrated activity and brought 11 pieces of material in 16 minutes. At 8:53, while her mate was beside the nest laying before her a straw he had just brought, the female, who had been sitting continuously for 102 minutes, unceremoniously stepped from the nest and walked off toward the end of the supporting branch. The male himself placed this last contribution, then came to stand close beside his companion. After two minutes both flew away; although I continued to watch until 9:30, they did not return. I had planned to resume observations the following morning, but long before sunrise there was an egg in this nest, and incubation had begun. Most of the work of building the structure had been done on two mornings between about seven and nine o'clock, and I had the good fortune to witness most of the construction of this nest.

Another nest near our house was completed in three or four days. In Surinam, Haverschmidt (1953) also watched the construction of a nest of the Ruddy Ground Dove which was finished in two days. Here also the doves carried a single piece of material at a time. Although building passerines often gather a whole sheaf of straws or fibers in their bill, most of the pigeons I have watched carried only a single piece of material on each visit. The only exception to this was a male Blue Ground Dove who seemed at times to hold several pieces, but it might well have been that these were all branches attached together. This restriction to a single article at a time is understandable in the Red-billed Pigeon, Short-billed Pigeon, Scaled Pigeon (*Columba speciosa*) and other species which break twigs or inflorescence branches from high in the trees, often struggling hard to detach them. It would be scarcely possible for them to pull away a stubborn piece while burdened with another item. This objection to carrying

several articles at once does not hold with the Ruddy Ground Dove, the Blue Ground Dove, the White-tipped Dove and others which glean loose bits of vegetation from the ground; it may be that their habit of bringing only a single piece at a time was inherited from ancestors that built their nests with materials gathered in the tree-tops. In any case, the capacity to seize one thing in the bill while holding another object is not so important to pigeons that feed their young by regurgitation as it is to small passerine birds that find this ability exceedingly useful in gathering a generous load of insects or other morsels for their nestlings.

Description of nest.—The nest of the Ruddy Ground Dove is a firm but slight and shallow, saucer-shaped structure, sometimes scarcely more than a platform with a shallow depression at its center. It is composed of straws, fine twigs and weed-stems and is lined with bits of dry grass and rootlets. One nest measured 3 by 2¾ inches in outside diameter; another, much bulkier, was 4½ by 4 inches. The nests are about two inches in height, and the hollow that contains the eggs is about two and one-half inches in diameter by one inch deep. Although barely big enough to hold the eggs, the nests of the Ruddy Ground Dove are as a rule substantially made, with thick walls; yet some, especially those which have a broad supporting surface, are flimsily constructed. The nest of this dove is generally to be distinguished from that of the Blue Ground Dove by its more solid construction.

THE EGGS

Time of laying.—The first egg may be laid on the day following the completion of the nest. At two nests, possibly both belonging to the same pair, the female came in the evening to sleep on the empty nest, and when she flew off, in the dim light of dawn next morning, she left the first egg. At four nests, the second egg was laid on the day after the first appeared; at one nest, two days intervened between the laying of the first and second eggs; and at another nest the interval was three or possibly even four days.

Even when the eggs are laid on successive days, the interval between the first and second egg may be greater than 24 hours, for in several instances the second egg was deposited considerably later in the morning than the first. Thus at nest 24, the first egg was laid before 5:30 a.m., but at 6:35 the following morning there was still only the single egg, covered by the male. The female was on the nest at 7:20 and 7:40; but I did not wish to run the risk of disturbing her in the act of laying, so I did not learn when she deposited the second egg. However, it was certainly laid more than 25 hours after the first. Similarly, at nest 27, the first egg was laid before 5:20 a.m.; the second was laid between 6:00 and 8:55 on the next morning. At one of Haverschmidt's nests in Surinam, the first egg was laid before 6:30 a.m. on one day, and the second was laid between 7:00 a.m. and 4:30 p.m. on the following day.

Size of set.—The full set of the Ruddy Ground Dove nearly always consists of two eggs. At times a nest with only a single egg is discovered, but one can seldom be sure in such cases that the other egg has not been lost. Not infrequently an egg is rolled from the shallow nest if the dove is frightened and darts away suddenly. Yet at one nest that I kept under observation during the period of laying, only a single egg was ever found; it was abandoned soon after it was deposited. Haverschmidt (1953) likewise found that only a single egg was laid in a nest that he watched closely. In British Guiana, Beebe, Hartley, and Howes (1917:213) found occasional nests of this species containing one egg and also some nests with three eggs. Sets of three eggs are most unusual among pigeons, and Belcher and Smooker (1936:4) state that they are of rare occurrence in the Common Ground Dove in Trinidad.

Description of eggs.—The eggs of the Ruddy Ground Dove are pure white and ellip-

soidal, with little difference in shape between the two ends. The measurements of 16 eggs average 23.2 by 17.1 millimeters. Those showing the four extremes are *25.4* by 17.5, 24.2 by *17.9*, and *21.8* by *15.9* millimeters.

Monthly distribution of sets.—In the basin of El General in Costa Rica, the eggs were laid in 29 nests as follows: January, 1; February, 4; March, 6; April, 8; May, 1; June, 4; July, 2; August, 1; September, 2. The majority of nests were found in the wet season, which extends from March to December or January. It is perhaps significant that three of my four February nests were found in the unusually wet February of 1937. At Palmar Sur, on the Pacific coast of southern Costa Rica, nestlings were found on September 20, 1947, and a pair was building a nest on October 20 of the same year. In Guatemala, a nest with eggs was found near Los Amates in the Motagua Valley on May 10, 1932, and two nests with eggs were found near Colomba, at 3000 feet above sea level on the Pacific slope in the Department of Quezaltenango, in July, 1935.

INCUBATION

Incubation of the first egg.—Incubation begins with or, if a paradox is permissible, even before the laying of the first egg; for we have seen that the female may sleep on the nest before she has laid any eggs, and she may sit quietly for long periods while building is in progress. Haverschmidt (*op. cit.*) also found that the female ground dove sat on the nest the day before she laid the first egg and slept upon it during the night before laying. After the deposition of the first egg, it is kept almost constantly covered until the second egg is laid. This is, in my experience, generally true of pigeons; it is doubtless important that the shining white egg be kept covered, lest it attract the eye of some predator. From the time the eggs are laid until they are hatched, they are rarely left exposed. For this reason, perhaps, selective processes have not been at work (save in a few exceptional genera like *Oreopeleia*) to create a pigmented shell that would be less conspicuous in the slight, open nest.

On the day the first egg is laid, the division of time spent on the nest by the male and female ground dove is wholly different from that followed after the second egg appears. At the nest in the clump of pineapple plants beside my house, the female flew off, leaving the single freshly laid egg, at 5:30 a.m. on April 5, 1943. At 6:05 I found the male covering the egg. The female was sitting at 7:27, 9:18, and 10:55 a.m. The male was again in charge at 12:15 and 3:30 p.m., but the female was back at 5:30 p.m. Next morning at 6:35 a.m., the male again covered the single egg.

Later in the season, at the nest I had watched the doves building in the annatto tree, the treatment of the single egg was somewhat different. This egg had been laid before 5:20 a.m. on the morning of June 15. At 6:00 a.m., I found the male covering it. At 6:24 he called *kitty woo* several times over, and a moment later I noticed his mate approaching. She came to stand above him, and after a brief delay he relinquished the care of the nest to her. At 7:37 a.m. she left spontaneously, after having sat quietly for an hour and 12 minutes. Her absence was short, and at 7:44 she returned to the egg. At 8:16 she cooed, then departed, as her mate approached with a straw in his bill. He laid it on the nest and sat on the egg. While incubating, he devoted considerable time to arranging the materials of the nest. Meanwhile, a Bananaquit (*Coereba flaveola*) was carrying off the straws from the unfinished nest two feet away. The male dove sat until after 9:00 a.m., when I ended my three-hour vigil. Returning at 1:35 p.m., I found the female on the nest. She was still there at 2:05, but at 3:20 the male was again sitting.

Hence at the nest on the pineapple plant, the male dove took at least two turns at covering the egg in a single day, and at the nest in the annatto the male took three turns, in each case with intervening sessions by the female. This is, of course, in marked con-

trast to the single long daily session that the male takes after the set of two eggs is complete. After incubation has continued for a few days, one never finds the male sitting as early as six o'clock in the morning, nor with rare exceptions does one find the female on the nest during the early afternoon.

Incubation of the full set.—The pattern of incubation of the Ruddy Ground Dove is similar to that of other members of the pigeon family. The male and female replace each other on the nest only twice each day. The female sits on the eggs in the afternoon and remains until her mate relieves her the next morning. He is then in sole charge through the middle of the day, until the female returns in the afternoon. Each member of the pair sits continuously until replaced by the other; if one should interrupt its long session, whether spontaneously or because disturbed, it normally returns to the nest in a few minutes. Thus the eggs are rarely left uncovered unless the doves are subjected to much interference from humans or animals. The hour when change of occupancy takes place varies somewhat from nest to nest, and even at the same nest from day to day; but as a rule the male is to be found covering the eggs from somewhat before mid-morning until about mid-afternoon whereas the female incubates from the late afternoon through the night, and into the early forenoon.

In the course of incubation, I maintained no continuous watch of the nest in the pineapple plant beside the house, but I looked at it frequently to learn which sex was in charge of the eggs. The latest hour of the morning at which I found the female on the nest was 7:55 a.m.; the earliest at which I saw the male there was 8:05 a.m. In the afternoon, the latest record of the presence of the male was 3:00 p.m.; the earliest record for the return of his mate was 2:50 p.m. Hence the male covered the eggs approximately from 8:00 a.m. to 3:00 p.m., or a period of about seven hours each day, during which time I never failed to find him at his post.

For the nest in the annatto tree, which presumably belonged to the same pair of doves, I have a large number of observations, because this nest could be watched from the porch, where the birds seemed indifferent to my presence. Here the latest hour at which I found the female incubating the two eggs in the morning was 8:40 a.m.; the earliest time at which the male was present was 8:27 a.m. The shift of occupancy occurred with fair regularity some time between 8:15 and 8:45 a.m.; one morning I witnessed this change at 8:34. In the afternoon, the earliest record for the return of the female was 2:45 p.m., but this occurred on the day when the second egg was laid. Thereafter, I did not see the female on the nest before 3:15 p.m.; on an afternoon with no heavy showers, she was usually to be found covering the eggs by 3:30 p.m. One afternoon toward the end of the period of incubation, I watched the female relieve her mate at 3:22 p.m. However, on afternoons of hard, long-continued rains, which were frequent at this season, she would sometimes come very late. Once she did not return until 4:13, and on another wet afternoon not until 5:01. In each instance the male sat faithfully, if impatiently toward the end, until relieved of duty. At most he would absent himself for a minute or two, probably to avoid soiling the nest, and from time to time while sitting he would call his tardy partner with soft *coo's*. At this nest, too, the male incubated normally for about seven hours a day, but on wet afternoons his period of duty might be prolonged to eight or even nine hours. Less methodical observations at other nests of Ruddy Ground Doves in southern Costa Rica have shown that this pair was fairly typical in the division of time on the nest during incubation. In only one instance, after the set of eggs was complete, have I found a female on the nest as late as 9:35 a.m.

But on July 21, 1935, at Colomba, Guatemala, I spent an entire day watching, from a blind, a nest where incubation had been in progress for at least six days. There I found a very different schedule. The female spent the night on the nest and sat continuously

through the morning, except for one brief, spontaneous absence of two minutes' duration, from 11:03 to 11:05 a.m., when possibly she went to drink. She did not leave until she heard her mate approaching at 12:38 p.m. As the morning wore on, and the male did not come to relieve her at the conventional hour, she called softly over and over, *kitty woo, kitty woo,* and once received an answer from the distance; but this exchange of greetings did not lead to her prompt release from incubation. The male went on the nest at 12:43 p.m. and sat continuously for two minutes less than five hours. Like his mate, he frequently closed his eyes for a moment while sitting. Silent at first, at half-past five he grew impatient over his mate's continued absence and began to coo in a voice somewhat fuller than hers. At 5:41 p.m. the female came back for the night, and the male flew off. In this instance, the female's arrival was not delayed by inclement weather, for the afternoon was fair; apparently she returned late merely because she had left late.

On subsequent days, I found the male dove on this nest earlier in the morning, at 11:00 a.m. on July 22 and 9:10 on July 23; but on July 24 the female was still on the nest at 9:10, although the male did come by 10:00. Apparently between 9:00 and 9:30 was his usual time for coming to the nest during the last few days of incubation. The female, having been relieved late in the morning, commonly kept her mate sitting far into the afternoon; 4:35 p.m. was the earliest hour at which I found her present; and twice more I found the male covering the eggs as late as 5:15 p.m. His daily session, roughly from 9:00 a.m. to 5:00 p.m. during the final days of incubation, lasted about eight hours.

In Surinam, Haverschmidt (1953) found that the male Ruddy Ground Dove almost invariably came to the eggs between 10:00 and 11:00 a.m. and sat until the female returned between 3:00 and 4:00 p.m. Sometimes the incubating bird was so reluctant to leave that the incoming partner had to push it from the eggs.

When approaching or leaving the nest, Ruddy Ground Doves do not fly directly to or from it, in the manner of hummingbirds and other very small birds with well-made nests and minute control of their flight. On the contrary, when coming to the nest they usually alight on a branch a foot or more away and walk to it. Similarly, when leaving they carefully step from the nest and walk out along the supporting limb before taking wing. In this fashion they are less likely to knock or shake the eggs from the shallow nest. It is only when suddenly alarmed that they fly directly from the eggs.

Far less careful of the sanitation of the nest than most birds, the doves sometimes soil the structure with their own excrements while they incubate, a not unnatural result of their very long periods of uninterrupted sitting. However, at times they appear to leave the nest for the purpose of voiding their droppings at a distance; their absence of a minute or two is hardly long enough to allow them to forage for food, although there might be sufficient time for them to drink water.

Adding to the nest.—On rare occasions I have seen doves make small additions to their nests after they had incubated for a number of days. At a nest built in my garden in 1942, I found the female bringing material to it only three days before the eggs hatched. Between 9:30 and 10:00 a.m., while her mate incubated, she brought at least seven pieces and placed them on the rim beside him. She walked over the lawn, bobbing her head in typical columbine fashion, and plucked at dry straws and fallen twigs until she found one loose and light enough to be moved. This she picked up and carried to the nest. She also brought the fibrous remains of a half-decayed leaf. Similarly, I once watched a female Blue Ground Dove take a number of twigs to the nest, between 9:00 and 9:15 in the morning, while her mate incubated the two eggs. This activity of the females in carrying material to the nest during the course of incubation is the more sur-

prising in view of the fact that when the nest was originally built I noted only the male of these two species taking material to it, while the female sat on the growing structure to receive and arrange the contributions. In the Ruddy Quail-Dove (*Oreopeleia montana*) both sexes often bring a leaf or twig when returning to the nest to incubate, but I have not seen them make special trips to add to their slight nests after the eggs are laid (Skutch, 1949:6).

Distraction display.—While incubating, the male Ruddy Ground Dove is as a rule more steadfast than his mate and will at times remain at his post in the face of an approaching man and suffer himself to be all but touched. At times, however, the female is almost equally staunch. The female studied by Haverschmidt (1953) in Surinam stayed on her nest while he removed the nestlings from beneath her for weighing, but none in my experience has been so brave.

I have rarely seen the Ruddy Ground Dove give a distraction display, probably because in the low thickets where they so often build their nests the vegetation is too dense to permit "injury-feigning." Even on plantations the ground is covered in most places with weeds too tall to allow the doves to perform in a convincing manner. At times, when disturbed, the dove will leave the eggs and drop toward the ground as though to alight, but on seeing the dense herbage it decides otherwise and skims off over the tops of the grasses and weeds. But one time in January, while I stood in a scrubby pasture near Cali, Colombia, a little before midday, a ground dove suddenly burst from a compact, spiny *Xanthoxylum* bush about twelve feet from me. He dropped to the ground and walked slowly away in a halting, wavering fashion, with raised, quivering wings that appeared to be painful and useless. I followed deliberately, and he continued to drag himself away in an unsteady course until out of sight among the bushes. Returning then to the thorny shrub, I found his nest with two eggs.

One morning in Costa Rica I found a male Ruddy Ground Dove brooding two newly hatched nestlings in a nest situated in a thicket ten feet above the ground. He sat most steadfastly, but when I raised my mirror to the level of the nest he jumped off and dropped to the ground in the midst of the thicket. Here he stayed for about a minute, flapping his wings violently and making loud sounds as they struck against the surrounding vegetation. The foliage between us was so dense that I could see little of him, but the noise he made was sufficient evidence of what he was doing. It was the best demonstration that he could make amid such tangled vegetation, and considering his handicaps he did very well.

Incubation period.—I have determined the length of incubation at four nests. At two nests, each containing two eggs, the incubation period was 12 days or a little less, counting from the laying to the hatching of the last egg. At two other nests it was 13 days. In four of my nests, both eggs hatched on the same day; in two, on consecutive days. In Surinam, Haverschmidt (1953) found the incubation period of this dove to be 12 days at one nest and 13 days at two other nests. He determined the incubation period of the related *Columbigallina minuta* to be 13 days in one instance. The eggs of these small doves of open country and secondary vegetation require a day or two more of incubation than those of the larger Ruddy Quail-Dove of the heavy forest. However, they hatch in considerably less time than those of many of the pigeons of northern lands (Skutch, 1949:7).

CARE OF THE NESTLINGS

The newly hatched Ruddy Ground Doves have pink skins with a sparse, buffy, hair-like down, and their eyes are tightly closed. The shells from which they escape promptly disappear from the nest, but whether eaten by the parents or carried off I have not learned.

It is not easy to find a nest conveniently situated for a study of the mode of feeding the young. Of those I have noted in recent years, the most favorable was the one found among the pineapple plants beside our house. By placing a stool atop a box inside the blind, I could look down on this nest from close at hand. But even with this advantage my post was not wholly satisfactory, for much of the time the parents sat with their tails toward me and I could not see plainly when they fed the nestlings. I devoted a total of about 29 hours to watching this nest from the blind, but my study was prematurely terminated by the disappearance of the nestlings when they were eight days old. In most small birds, a fairly satisfactory picture of the way the young are attended can be obtained by watching the nest for sample periods of a few hours' duration. But because of the peculiar manner of feeding the nestlings in the pigeon family, one may watch for hours without witnessing the transfer of food. No trustworthy deductions as to the times of feeding can be drawn from observing the times of the parents' return to the nest; this is especially true when the young are only a few days old. To learn in detail how the nestlings are fed, continuous all-day vigils are necessary. Thus it would be desirable to have two observers who could replace each other at intervals. A thorough study of the nest life of a wild pigeon would demand many hours of patient watching, but it should yield information of great interest.

One day old.—At daybreak on April 19, 1943, the day after the two nestlings hatched, I began to watch the doves' nest among the pineapple plants and continued until 3:40 p.m. I was seated in the blind continuously except for brief interludes at meal-times, when I watched from the window of the dining-room. From the latter viewpoint, I could not actually see the nest, which was screened from my view by the foliage, but I could see whether a parent came to it or left. The female dove was covering the nestlings at dawn and continued to sit quietly through the early hours of the morning. Once a nestling pushed its head from beneath her breast. At 7:31 a.m. the male flew down into the clump of pineapples near the nest. The female rose, cooed softly, and lifted and vibrated her wings. As the male approached the nest walking down the long pineapple leaf on whose base the nest rested, the female backed to the farther rim of the structure. There she had difficulty in taking off, for the spiny pineapple leaves clustering around did not leave space for her to spread her wings. Finally she hopped upon a fallen stick which gave her a slight elevation and thence gained the air. The male perversely settled on the nest with his tail toward me.

Ten minutes after his return to the nest, the male dove bent down and appeared to feed the nestlings, but since his head was concealed from me by his body, I could not be sure of this. Three minutes later he appeared to feed again. He was continually trembling and panting as he sat on the nest, although the sun was still low in the east and the air cool. Between 8:00 and 8:33 a.m. he fed the nestlings three times—I could see this action more clearly. Then followed an hour and a half of quiescent brooding. At 10:04 and 10:14 he seemed to deliver more food, but again his head was invisible to me. But at 10:28 he turned sideways, and I saw him feed both nestlings several times, alternately, in brief installments spread over a period of four minutes. Taking the nestlings' bills into his own mouth, one at a time, he regurgitated the "pigeon's milk" from his crop, a process which appeared to require considerable muscular effort and was accompanied by jerky movements of his body which gave the little ones' heads a good shaking. Other brief feedings followed at 10:35 and 10:54, and again between 11:07 and 11:19 he spent much time giving food to the nestlings, devoting five minutes to intermittent regurgitation for the benefit of a single one. From 12:20 p.m. to 12:56 p.m. there were many more feedings, one nestling receiving nourishment intermittently over a period of ten minutes.

At 1:00 p.m. the male dove left the nest for the first time since his arrival five and one-half hours earlier. He flew toward the neighboring creek and returned from the same direction only four minutes later. Doubtless he had gone to drink, for through much of the morning he had been sitting in the hot sunshine and had panted a great deal, and also he had given much liquid nourishment to the nestlings. Although he had scarcely been gone from the nest long enough to find food, eight minutes after his return he rose up and gently seized the tips of the nestlings' bills, alternately. Finally he induced one to stretch up its head and take a little food; but the young seemed not to be hungry now and lay quietly in the nest. At 1:42 p.m. he started to call *kitty woo* in a low voice, and during the next three-quarters of an hour he cooed many times over. He was becoming restless now and often shifted his position in the nest. From time to time he gave still more food to the nestlings, once billing one of them until it responded by rising up to take nourishment. Then at 2:26 he walked out along the pineapple leaf and flew away, but after 20 minutes he returned and resumed brooding, calling again and again while he sat. Finally, at 3:15, the female arrived and he went off. She dropped down among the spiny leaves at a point about a foot from the nest and seemed to have difficulty in passing through them to reach the nestlings. It was 3:33 before she got to the young and began to brood. She had not offered them food by 3:40, when I was obliged to terminate my long vigil.

Thus on the nestlings' second day of life outside the shell they were constantly attended save for two short absences of the male, totalling only 24 minutes, and the interval between the female's return to the pineapple patch and her delayed arrival at the nest. The parents divided the care of the nest between them much as in the days when they were incubating, except that now the male arrived about half an hour earlier in the morning than I had ever seen him at the nest during incubation, and, in the afternoon, the female came somewhat later than had been her custom. The male dove appeared to be chiefly responsible for feeding the nestlings. He seemed to have an inexhaustible supply of nourishment in his crop, and he continued to pass it to the nestlings at intervals through most of his long stay of nearly eight hours on the nest. He last regurgitated food to them at 2:10 p.m.

Two days old.—The following day, April 20, I watched from the blind so as to record events at the nest during those hours I had missed on the preceding day, including the brief interval when I had watched through the window as I sat at breakfast and could not see in detail what had happened. The female was brooding the nestlings at daybreak. At 5:39 a.m. one of them pushed out from beneath her breast and stretched up in front of her. She fed it for four minutes, then dropped its bill and grasped that of the other, which meanwhile had emerged from the other side of her breast. She regurgitated to this second nestling for only two minutes, then both retired beneath their mother's warm feathers. Thus, unlike the great majority of birds, she was able to feed her nestlings in the morning before she herself had eaten. During the remainder of the morning and the early afternoon I made only occasional visits to the nest, finding the male present at 9:00 a.m., noon, and 1:30 p.m., but the young were unattended from 1:45 to 2:30 p.m. At the latter hour, when a storm was threatening, I entered the blind. At 2:45 the female flew twice by the nest, alighting each time in another part of the clump of pineapple plants. I cannot explain why she did not go directly to the nest. At 2:55 a light shower fell. At 3:10 the male returned to the nest, walking down the pineapple leaf as usual. He stood above the nestlings, twitching up his left wing, and while he delayed in this position his mate arrived. For about two minutes the pair faced each other across the nest, bobbing their heads and twitching their wings, which I later learned was their usual practice when they met at or close to the nest. Then the female

pushed herself over the nestlings and the male flew away. While she brooded, a small brown grasshopper walked over the nest's rim. She paid no attention until it crept up on her breast, when she gave it a sharp peck that made it hop away. I continued to watch until it grew so dark that I could hardly distinguish the dove on her nest, but I did not see her feed the nestlings once after her return.

Four days old.—Each day the male dove came to the nest a little earlier in the morning. On April 19, the day after the nestlings hatched, he arrived at 7:31 a.m.; on April 21, he came at 7:03; on April 22, at 6:50. On this last date the female had departed from her earlier practice of remaining on the nest until he replaced her and was absent when I entered the blind at 6:35 a.m. Arriving at 6:50, the male alighted far out on the pineapple leaf and walked slowly along it to the rim of the nest, where he stopped and cooed softly. The nestlings now had open eyes and reached up for food almost as soon as their father reached them. Formerly the young doves had been fed one at a time; but now that they could see, both tried to put their bills into their parent's mouth at once, one on each side, and they were sometimes successful in this endeavor. The process of regurgitating food to the nestlings continued intermittently for about 12 minutes and was accompanied by fairly violent jerking movements of the parent's body. Then, after a ten minutes' rest, he resumed feeding, this time taking the nestlings' mouths alternately into his own and continuing feeding in this way for five minutes. Then there was an eight minutes' rest followed by five minutes more of regurgitation. The male dove did not tremble as he had done on previous mornings. Next followed a long rest, from 7:30 to 8:56 a.m., at the end of which time he fed the young intermittently for 17 minutes. At 10:08 he again gave food to a nestling, but for only a few seconds. Although I continued to watch until 11:30, the youngsters received no more nourishment. From time to time they would rise up in front of the male, silently importuning to be fed; then he would sometimes take the bill of one into his own, only to drop it at once, without giving anything. Three mornings earlier, the male dove had regurgitated food to the nestlings whenever one of them had lifted its sightless black head and bobbed about, and he had even coaxed them to eat when they showed no inclination to do so, continuing his feedings until 2:10 p.m. The preceding day he had fed freely until at least 11:14 a.m. But now he had practically exhausted the contents of his crop by 9:13 a.m., after which he delivered only one very skimpy meal at 10:08. As the nestlings grew older, they evidently drained the "cup" more quickly.

The male dove sat continuously from 6:50 to 11:30 a.m., except for a nine minutes' absence from 11:09 to 11:18, when he had flown off toward the creek, evidently for water. While this male covered the nestlings, another male Ruddy Ground Dove cooed persistently in a guava tree about a hundred feet away and was repeatedly answered by the one on the nest. When the sun shone brightly, the parent stood over the nestlings to shade them rather than brood. Although the parents devoted much time to their family, they were somewhat inconsistent in the care of the young. When only three days old, the young doves, practically naked, were left uncovered in a hard shower which began soon after midday. Also the parents at times carelessly stepped on the young when going on or off the nest, but this apparently caused the little ones no harm.

Seven days old.—At 12:30 p.m. on April 25, I began my last long vigil at this doves' nest. The nestlings, now a week old, were alert and active, and their feathers were beginning to break from the sheaths on the back and wings. The young were alone when I arrived at 12:30 p.m. and continued so for the next hour, despite a sprinkling of rain. At 1:25 p.m. the male returned, cooed in a low voice while perching at the top of an arching pineapple leaf, then approached the nest by walking down the leaf that supported it. The youngsters appeared to take no notice of him until he stepped on them,

when they rose up and placed their bills in his mouth for a feeding. For about five minutes he continued to regurgitate food, at times to one alone, at times to both together. The meal over, he crossed to the other side of the nest and faced east, stepping many times on the nestlings, who appeared not to mind this rough treatment. He stood on the edge of the nest, facing me, one of the young doves mostly beneath him, the other mostly outside him, with only its head beneath the paternal breast. After a while the youngsters stretched their wings and preened. Then one took exercise, beating its wings.

At 2:03 p.m. the female replaced her mate on the nest. This was, with a single exception, the earliest hour of the afternoon at which I had seen her there. On April 19 she had returned at 3:15; on April 20, at 3:10; on April 21, at about 2:25; on April 22 she had returned by 1:23; on April 24 she was present at 2:15. She had been coming back to the nest a little earlier each afternoon, if we omit her exceptionally early return on April 22. Now, on April 25, she came at 2:03 and soon after her arrival fed the nestlings, first one alone, then both together, on opposite sides of her mouth, then one alone. The transfer of food lasted four minutes, and when it was over she cooed softly. The youngsters continued to be active, preening and stretching their wings, and from time to time the female gave them gentle pecks. She stayed at the nest only 41 minutes. When the nestlings were two days old, it will be recalled, she covered them continuously from her return in mid-afternoon until nightfall; but when they were four days old she had gone off after a spell of brooding in the early afternoon.

After the female's departure at 2:44 p.m. on April 25, the week-old doves remained unattended until their father returned to the pineapple clump at 3:12. At that time he lingered on the leaf a yard from the nest, not going to feed the nestlings until 3:25. The afternoon then became darkly clouded and cooler, and after a meal which lasted four minutes the male settled down to brood. The female returned at 3:50 and rested on a pineapple leaf near the nest, but her mate made no move to relinquish the young to her care, and after a minute or two she went off. Soon a light rain began to fall. After an absence of a half-hour, the female reappeared, perched in a neighboring annatto tree, and exchanged soft coos with her mate on the nest. After a quarter of an hour more, she proceeded to the pineapple clump. The male seemed reluctant to go, but finally made way for her, and they passed each other on the leaf that formed the pathway to the nest. At 4:37 p.m. she settled down to brood without giving another meal to the youngsters, who seemed not to be hungry. As darkness fell I stole away, leaving her quietly covering her nestlings. At daybreak I returned to the blind, but the slowly growing light revealed that the nest was empty! The female had escaped, for later in the morning I saw her with her mate near the empty nest.

Resumé of observations at the nest on the pineapple plant.—When the nestlings were a day or two old they were brooded almost constantly, the parents occupying the nest according to much the same schedule they had followed during the period of incubation. The male covered the nest most of the day and was the chief provider of nourishment. When he arrived at about 7:30 in the morning he brought a seemingly inexhaustible supply of "pigeons' milk," which he regurgitated into the mouths of the nestlings at short intervals through the morning and early afternoon. He was not obliged to go off and hunt food in order to replenish his supply, and his short absences from the nest, lasting only a few minutes, were apparently for the purpose of quenching his thirst. After her return in the middle of the afternoon, the female did not feed the nestlings; but next morning, before taking food herself, she was able to regurgitate a small amount of food to the young.

As the nestlings grew older, the male came to the nest earlier in the morning. He appeared to give the young doves a greater amount of food at one time, and he exhausted

the contents of his crop earlier each succeeding day, so that he was no longer able to respond to their subsequent requests for nourishment. While the youngsters were still blind he fed them singly; but after their eyes opened, when they were three or four days old, they could see to place their bills in the parent's mouth and were often fed simultaneously. Each day the male would remain away from the nest for a longer period in the early afternoon. Even on their third day the naked nestlings were left exposed to a shower that began soon after noon. The female dove returned to the nest progressively earlier each afternoon, and when the nestlings were a week old fed them at this time. When the nestlings were four days old, the male began the habit of returning to replace his mate about the middle of the afternoon, now taking two turns on the nest each day, whereas formerly he had not returned after his mate had once replaced him in the afternoon. He now fed the nestlings, brooded them for an hour more or less, then was relieved by the female, who, without again feeding the nestlings stayed with them until nightfall. When the young were a week old, the parents came to the nest twice as often as when the young were newly hatched, yet at the same time they gave them far fewer meals, apparently because each meal was more liberal and the contents of the crop more quickly exhausted.

In Surinam, Haverschmidt found young Ruddy Ground Doves invariably attended by one of the parents during the daytime until a day or two before they were ready to fly. In contrast to this more constant brooding or guarding, his observations showed less frequent feeding than at my nests in Costa Rica. In reducing the number of feedings as the nestlings grew older, my Ruddy Ground Doves resembled the Blue Ground Dove and the Ruddy Quail-Dove (see Skutch, 1949:14–15).

DEVELOPMENT AND DEPARTURE OF THE NESTLINGS

From nests that were successful, we are able to trace the development of the young Ruddy Ground Doves from hatching until their departure. Upon hatching the young are, as we have seen, pink, blind, and thinly covered with buff-colored, hair-like down, which does not cover their nakedness. The skin rapidly darkens, and when two or three days old they are nearly black. At the age of three or four days their eyes are open. The pin-feathers now grow out rapidly and are long and conspicuous on the five-day-old nestlings. The little doves now peep softly. At the age of eight days they are nearly clothed with feathers which have meanwhile shed their sheaths. A day later, the nestlings' bodies are well covered, although their heads are still bristly with unopened pin-feathers, each terminated by a little tuft of buffy bristles. The young birds can now fly a little and will leave the nest if frightened, although if undisturbed they linger from three to five days longer. A dove, which fluttered prematurely from the nest, held its wings raised above its back in a defensive attitude when I attempted to pick it from the ground.

The nest, which is sometimes lightly soiled by the parent doves during incubation, becomes increasingly dirty after the eggs hatch, for the parents make no effort to preserve the structure in a sanitary condition. Before the nestlings take wing, the nest is heavily laden with their dried droppings. In the matter of the sanitation of the nest, there are great differences among the species of pigeons. Although the Ruddy Ground Dove and the Blue Ground Dove permit their nests to become filthy, the White-tipped Dove and the Ruddy Quail-Dove keep their nests scrupulously clean until the nestlings depart. The Scaled Pigeon and the Red-billed Pigeon do so at least until the young are feathered.

The parent Ruddy Ground Doves spend considerable time on the nest with the young even when these are 12 days old and have for several days been well covered with feath-

ers. But, as when the nestlings are younger, they are not consistent in their attention. Although they often cover the youngsters in fair weather when this seems superfluous, they may leave them exposed to heavy rain. The female broods the young through the night until they are 12 or 13 days of age. When sleeping on the nest, she does not turn her head back and bury it in the plumage of a shoulder but lets it droop forward until her bill touches the fluffed out feathers of her breast; this I noted repeatedly on my nocturnal visits. When 11 days old, the young dove may hop from the nest and perch a few inches away from it, returning later to be brooded.

On visiting a nest in an orange tree early one morning, I found the male dove brooding two fledglings 12 days old. As he flew off, one of the youngsters followed, flying easily to a tree about 25 feet distant. When I lifted up a mirror to see whether the other young dove remained on the nest, it flew to perch on a neighboring thorn, then back to the rim of the nest. At noon this nest was empty. The fledglings were in neighboring trees, and although able to fly well, they found difficulty in alighting, sometimes missing the intended perch and fluttering down to the grass. That evening both returned to their heavily soiled nest to be brooded by their mother. When I visited the orange tree on the following evening, both young doves flew out. Apparently they were returning, after two days of activity among the surrounding trees, to sleep once more upon the nest. So far as I could learn, without making another disturbing visit to this nest, they did not again return that evening; but their mother flew from the nest when I visited it before sunrise next morning. At another nest, a single nestling, which likewise had left the nest at the age of 12 days, failed to return for an additional night's brooding. From a third nest, two young doves departed at the age of 14 days. Haverschmidt found the nestling period of this species to be 11 to 12 days in Surinam. Although the nestling period of the Ruddy Ground Dove is substantially longer than the eight or ten days of the Ruddy Quail-Dove, it is very much less than the three or four weeks or even more of some northern species of *Columba*.

Doves are sometimes reported to be less flexible and adaptable than songbirds, but this is not always true. One day, during the course of pruning a banana plantation in Panamá, a plant bearing a bunch of green fruit was cut down before it was discovered that it supported a Ruddy Ground Dove's nest with two small nestlings. Fortunately, in the fall of the stem, the nest was not thrown from the fruit nor the youngsters from the nest. I placed nest and nestlings in a corresponding position on a younger bunch of bananas in the same cluster of stems. Two hours later I had the satisfaction of seeing the female dove brooding her offspring in the new location. I have known songbirds of several species to feed but fail to brood callow nestlings when their situation was changed in a corresponding fashion.

NUMBER OF BROODS

A second brood often follows swiftly after the first. A pair of doves, whose single nestling departed successfully on April 1, had, by April 8, already covered over the old nest with fresh straws, and next day the first egg of a new set had been laid. Another pair, whose two fledglings flew from the nest on March 14, had relined the old structure by April 3, and the following day they had an egg. A pair, whose two nestlings took wing on August 31, were, on September 17, building a new nest a yard distant from the first. However, this nest was never finished, probably because of the lateness of the season. In the nest which Haverschmidt (1953) studied in Surinam, three broods were reared between October 25 and the following February 24.

The breeding season of the Ruddy Ground Dove in Central America covers most of the year. Since the whole breeding cycle is completed in about five weeks, in this long nesting season of eight to ten months there would be time for a single pair to rear six

or seven broods. Nevertheless, I greatly doubt whether any pair actually produces, or even attempts to produce, so many broods in the course of a year. I, personally, have no evidence for more than two broods in the same breeding season. Belcher and Smooker (1936:5) state that in Trinidad this species breeds throughout the year, but most of their nests were found in May and June, and again in December.

SUCCESS IN NESTING

Of the 34 nests that appear in my records, I know the outcome of 21 that were found before the eggs hatched. Nineteen of these were in El General, Costa Rica, and two near Colomba, Guatemala. These 21 nests contained 40 eggs, of which 20 hatched. Of these 20 nestlings, eight young fledged from five nests. Calculated on the basis of eggs, the nesting success was 20 per cent; while on the basis of nests it was 24 per cent. Approximately one-quarter of the nests produced at least one living fledgling. In an area of three and three-quarters acres of shady pasture and lawn surrounding my house, I found, in 1943, seven nests belonging to three or four pairs of doves. In 1949, there were only two nests belonging to two pairs of doves. Of these nine nests, two are known to have been successful, producing at least one fledgling each, and five are known to have failed. In this smaller sample, the nesting success was slightly higher than in the whole number of nests, in which this group is included. Beebe, Hartley and Howes (1917:213) said of the Ruddy Ground Dove in British Guiana that "not more than half the young ever reached maturity."

The only predator I have caught in the act of pillaging a Ruddy Ground Dove's nest is the Fiery-billed Araçari (*Pteroglossus frantzii*), which, late in the afternoon of September 8, 1948, ate the two eggs from a nest in front of our house. The other known causes of loss are: one nestling died in the nest; one egg fell from the nest; and one nest with a single egg was abandoned.

In the area near our dwelling where there were seven nests in 1943 and two nests in 1944, I found only two in the next 11 years, both in 1948. While there is somewhat more shrubbery and shade, and slightly less bare ground, conditions in this area seem much the same as they were in 1943. I cannot explain the decrease in the number of Ruddy Ground Doves in this area, while in other parts of the valley they are still numerous.

SUMMARY

The Ruddy Ground Dove (*Columbigallina talpacoti*) inhabits plantations, pastures, and low second-growth vegetation in the more humid parts of the Central American lowlands, from sea level up to about 3500 feet altitude. This dove forages on the ground, often in small flocks.

Mated birds perch in close contact and bill each other's feathers.

Nesting begins no later than December in Colombia and it starts in January in southern Central America. The shallow but usually compact, open, cup-like nest is placed in bushes and trees from one to 30 feet high, but most often it is from four to eight feet high. Sometimes the old nest of some other bird serves as a foundation. Nests on the ground are not known.

The male takes the initiative in building and the female seems willing to use whatever site he prefers. Following his lead, she sits in the nest site and he brings material, which he lays beside her while standing on her back. She then shuffles the straws into place. When the female is absent, the male himself places and arranges the material he has brought. He gathers this material from the ground and carries only one piece at a time. The nest is finished in two to four days.

The female spends long periods on the nest the day before she begins to lay and

sleeps there through the night preceding the appearance of the first egg, which is laid before sunrise. The second egg is often laid the day after the first but at a later hour, so that the minimum interval between the laying of the two eggs is 25 hours or more. Sometimes two or even more days elapse between the laying of the first and second eggs.

The set nearly always consists of two eggs. Sometimes, however, only one egg is laid, and sets of three eggs have been reported.

In Costa Rica, nests were found in every month of the year except November and December, but eggs are found mostly in March and April. Breeding is chiefly in the wet season.

The first egg is kept almost constantly covered by the doves; at this stage the parents change places on the nest more frequently than they do after the set is complete. Instead of a single daily period of occupancy, the male may take two, three, or possibly more turns at incubating the egg, with intervening sessions by the female.

After the set of eggs is complete, the male normally incubates for one long period lasting about seven hours each day. This extends from somewhat before the middle of the morning to about the middle of the afternoon. The female incubates from mid-afternoon through the night until her mate returns on the following morning. On afternoons of long-continued, heavy rain, one female left her mate sitting until about five o'clock. At a nest in Guatemala, the male sometimes left his mate in charge until past noon, then replaced her and sat until evening. Usually each partner sits continuously until relieved by the other. If the one that is incubating has occasion to leave the nest, it usually returns in a few minutes. The doves sometimes soil their nest while incubating.

Three days before the eggs hatched, one female brought a number of straws to the nest while her mate incubated. Similar behavior has been observed in the Blue Ground Dove.

Incubating or brooding parents sometimes give a distraction display.

The incubation period is from somewhat less than 12 days to about 13 days.

When nestlings are one or two days old, the parents occupy the nest, using much the same schedule as they follow during incubation, except that the male now comes slightly earlier in the morning. He regurgitates food to the young many times over a period of more than six hours, often coaxing them when they are sluggish in responding. The female does not feed the young after her return in the middle of the afternoon, but is able to regurgitate to them the following morning before she leaves the nest. Until their eyes are open, the young are fed singly, but after they can see they often take food simultaneously.

As the days pass, the male parent comes to the nest at an earlier hour in the morning and the female returns earlier in the afternoon. On the seventh day at one nest she came at two o'clock, fed the nestlings, and brooded for only 41 minutes. The male returned in the middle of the afternoon, fed again, and stayed until the female came back for the night. Thus the female intercalated a period on the nest between sessions of the male, an arrangement never observed during incubation of these doves. Although the parents now came to the nest more often than when the young were newly hatched, they fed the young far less often, but seemed to regurgitate more food at each meal.

Although the parents sometimes brood well-feathered young ready to fly, they are most inconsistent and may leave smaller, naked nestlings exposed to rain. The female broods the young at night as long as they stay in the nest.

Unlike some other pigeons, the Ruddy Ground Doves do not clean the nest, which becomes heavily soiled with droppings.

The young are well feathered and can fly a little at the age of nine days, but unless disturbed they stay in the nest until 12 to 14 days of age, when they fly strongly but

have difficulty in alighting. The young may return to the soiled nest to be brooded by their mother for one or two additional nights after they leave the nest.

The old nest is sometimes renovated for a second brood, which follows from 8 to 21 days after the departure of the first brood. It is doubtful whether any single pair breeds throughout the long nesting season of eight to ten months.

Twenty-one nests contained 40 eggs, of which 20 hatched; but of these 20 nestlings only 8 fledged from 5 nests. The toucan *Pteroglossus frantzii* was the only predator seen to rob a nest.

LITERATURE CITED

Beebe, W., Hartley, G. I., and Howes, P. G.
1917. Tropical wild life in British Guiana (New York, New York Zool. Soc.).
Belcher, C., and Smooker, G. D.
1936. Birds of the colony of Trinidad and Tobago. Part III. Ibis, 1936:1–35.
Haverschmidt, F.
1953. Notes on the life history of *Columbigallina talpacoti* in Surinam. Condor, 55:21–25.
Skutch, A. F.
1949. Life history of the Ruddy Quail-Dove. Condor, 51:3–19.

El Quizarrá, San Isidro del General, Costa Rica, September 14, 1955.

THE ANNUAL REPRODUCTIVE CYCLE OF THE CALIFORNIA GULL
II. HISTOLOGY AND FEMALE REPRODUCTIVE SYSTEM

By DAVID W. JOHNSTON

The first part of this paper dealing with the criteria for age determination in the California Gull (*Larus californicus*), with the size of the testes and seminiferous tubules, and with the stages of spermatogenesis appeared in the preceding issue of the Condor (Johnston, 1956). The conclusion of this work concerns further phases of the male reproductive cycle, namely, intertubular histology of the testis, incubation patches, and subadult breeding, and it presents data on the female reproductive cycle. Also included in Part II is a general summary.

INTERTUBULAR HISTOLOGY OF TESTIS

Several different kinds of intertubular cells have been described from several different species of birds, and there is limited agreement among various authors as to the morphology and physiology of the intertubular cell types. Some of these differences in opinion undoubtedly stem from the fact that different species have been studied. Other authors, however, working in a less detailed fashion, have merely referred to the presence or absence of secretory interstitial cells without reference to the other morphological types present, but the recent work of Marshall (1949) indicates that the complete morphological picture of intertubular tissue must be understood before the secretory nature of the cell types can be correctly interpreted.

At least two detailed studies of intertubular histology have been carried out recently: on the White-crowned Sparrow by Blanchard and Erickson (1949) and on the Fulmar by Marshall (1949). These authors recognized six or more different morphological cell types in the intertubular areas in each of these species, and it is possible to equate some of these types between the two species. Microscopic examination of testes from the California Gull revealed the fact that most if not all of the intertubular cells in this species were rather similar to those described and illustrated by Marshall for the Fulmar. Since Marshall utilized special stains to differentiate some of the cell types, it was not possible in all cases to compare directly the different kinds of cells between the Fulmar and the California Gull. Furthermore, in the gull material no attempt was made to relegate connective tissue cells to the detailed subgroups which Blanchard and Erickson recognize.

In the California Gull the following kinds of intertubular cells were identified:

1. *Melanoblast.* These cells may vary in size and shape but generally are large and dendritic. At times, especially during the winter and in subadult birds, the melanin granules tend to obscure other intertubular cells as well as the structure of the melanoblast itself.

2. *Juvenal interstitial cell.* This kind of cell was not investigated as thoroughly with special stains as it was in Marshall's study. It is generally recognized by its relatively small size and rounded appearances of cytoplasm and nucleus. As Marshall points out, this type is common in immature birds and adults not in breeding condition. Presumably, these cells develop into the next type. If they do, there is a great mortality because the mature cells are never as numerous as the juvenal ones.

3. *Mature interstitial cell.* It was sometimes difficult to decide whether a given cell was juvenal or mature due to gradations in size, but a typical mature cell is larger than any other intertubular cell type. Usually, in breeding adults the mature cells are clumped together in groups up to about ten, but occasionally a single cell is wedged in the intertubular spaces. Some cells identified as this type, on the basis of size alone, might have been the fuchsinophil type found by Marshall and others.

4. *Connective tissue cell.* This is the most consistent type of cell found in the intertubular spaces and is at times the dominant cell type present. These small cells have spindle-shaped nuclei and cytoplasm and are about the same size or perhaps a little smaller than the juvenal interstitial cells.

Many of the standard works which deal with avian reproductive cycles and the histology of testes have emphasized the cells which secrete androgens. Marshall's interpretations seem to be the most plausible at the present time, primarily because he has combined special staining techniques with analyses of the morphological cell types and has correlated these findings with the breeding biology of the bird. He believes the juvenal interstitial cells are found primarily in the nonbreeding season and that these cells develop into mature lipoidal secretory interstitial cells during the breeding season. His interpretation of the secretory cells is diametrically opposed to the views of Sluiter and van Oordt (1947) who believe that the lipoid cells do not secrete androgens but that a nonlipoid cell, "secretory cell B," is the source of androgens. Contemporary knowledge of the chemical structure of androgenic steroids favors Marshall's view.

Seasonal changes in the size of interstitial cells occurred in the form of a gradient, beginning in late January and culminating in the largest cells at the height of the breeding season. These observations would seem to support Marshall's contention that the juvenal interstitial cells increase in size, becoming largest and secretory during the breeding season.

Mature interstitial cells have been counted or estimated in a variety of different ways in many vertebrates, but, since only relative abundance was desired, a simple method has been utilized in this study. The criteria of relative abundance used by Blanchard and Erickson (1949:268) for all intertubular cell types have been adopted for the gull material with only a few changes. These criteria are as follows:

1. Abundant—comprising all of the intertubular area except for a few other cells.
2. Common—the predominant intertubular cell type. About ten cells visible in any field of a given section at 400×.
3. Fairly common—one to three cells visible in any field of a given section at 400×.
4. Occasional—five to ten cells in a given section.
5. Rare—one or two cells in a given section.
6. Absent.

None of the cell types was ever recorded as abundant, but in certain instances connective tissue cells or juvenal interstitial cells approached this category. The most difficult distinction arises in trying to decide when the cells are rare or absent. Considerable searching might reveal only one cell in a section, while diligent search of material from another bird with essentially identical testes might reveal no cells. The difference here might be due only to sampling technique. Physiologically, there is probably little difference between these two stages.

A graphic presentation of the mature interstitial cell cycle is presented in figure 1. For all practical purposes, the mature interstitial cells are absent during the winter months.

Intertubular areas in winter in all age groups are characterized by having a predominance of connective tissue cells and juvenal interstitial cells. Only an occasional capillary can be found. Variable amounts of melanin are present and, depending upon size of the testis and age of the bird, impart a black or brown color to the entire testis. Frequently, these melanin deposits obscure the quantity and quality of intertubular cells, especially in first-year birds when the melanin is concentrated. These findings are in general agreement with the observations of Marshall and other workers who have reported correlations among melanin deposition, size of the testis, and gross color of the testis.

Mature interstitial cells first begin to appear in January in all but first-year birds. Concurrently, other changes in the intertubular areas occur as the breeding season approaches. The once abundant melanin deposits gradually disperse or disappear, at least

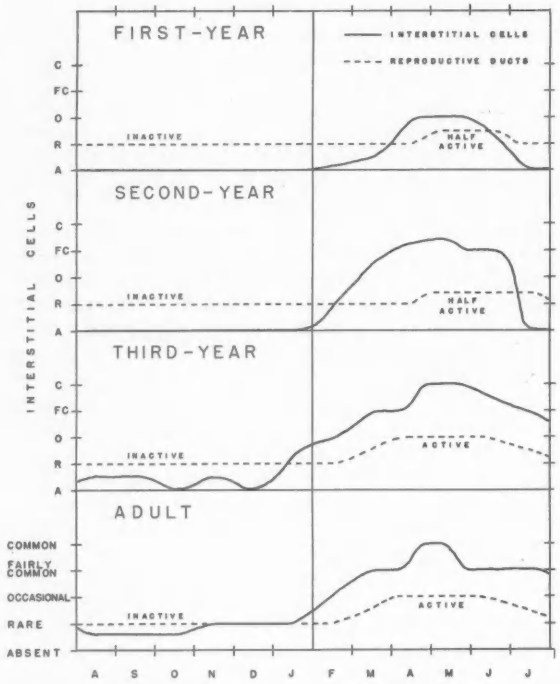

Fig. 1. Correlation between relative abundance of mature interstitial cells and activity of reproductive ducts.

in birds with the largest testes, until at the height of the breeding season no more melanin can be found either in intertubular areas or in the tunica albuginea. As the mature interstitial cells increase in number, the juvenal ones decrease and are entirely absent when the mature type reaches its greatest peak of abundance. No visible differences, except in relative abundance, could be detected among the interstitial cells of the various age groups of the gull. Breeding and regressing testes have many intertubular capillaries.

Several further facts are revealed in figure 1. First-year and second-year birds never have as many interstitial cells as the other age groups, this fact being correlated with less developed reproductive tracts and duller coloration of the soft parts. Second-year birds, however, during the spring months have more interstitial cells than first-year birds. Third-year and adult birds are essentially alike in numbers of these cells present, and there are no differences between the nonbreeding and breeding third-year birds.

In many aspects the interstitial cell cycle of the California Gull follows closely cycles described for other birds. First-year Fulmars, according to Marshall, have mostly juvenal interstitial cells, whereas adults have increasing numbers of mature interstitial cells as the breeding season progresses. Similarly, in the British Starling, Bullough (1942:174–180) has described an interstitial cell cycle which begins with first-year birds having "not common" interstitial cells when their testes are at maximum size

(80.1 mm.^{3}; both testes combined). During the winter months, these cells are rare or absent, but, when the adults come into breeding condition (testis mean 3988.2 mm.^{3}; both testes combined), the interstitial cells are common. As in the gulls, a correlation may be established among number of interstitial cells, size of reproductive ducts, and intensification of bill coloration.

In male Red-winged Blackbirds, Wright and Wright (1944:53) state that "Leydig cells appear to be absent when the testes are at a maximum, during regression and during the inactive period." But this is not generally true of birds. The various studies already mentioned for the White-crowned Sparrow, Oregon Junco, Fulmar, and Starling have shown that interstitial cells are present in various quantities at the height of the breeding season. Similarly, in the California Gull, it has been shown that mature interstitial cells are present in third-year and adult birds from at least February until July. As Wright and Wright indicate, it is generally true that in birds the intertubular material is relatively less abundant than tubular material in testes of maximum size. At this time, however, at least in most species which have been studied thoroughly, interstitial cells may occupy much of the intertubular area.

In the California Gull, as in other species of birds which have been studied, there is a direct correlation between the maximum number of adult interstitial cells and maximum development of the reproductive ducts. Bouin and Ancel (1903, 1904) first " . . . demonstrated that only when the interstitial cells were large and filled with lipid droplets were the secondary sex organs well developed; that in species with seasonal sexual activity, the secondary sex organs developed concomitantly with the interstitial cells, whereas the activity of these glands bore no constant relation to the condition of the spermatic tubules. . . . " (from Deane and Seligman, 1953:176). Although this generality exists for vertebrates, it has nevertheless been shown that an inverse relationship occurs in the garter snake (Fox, 1952:532) and the lump-nosed bat (Pearson, Koford, and Pearson, 1952:286).

Oslund (1928:263) maintains that there is an increase in the number and volume of the interstitial cells in birds during the period of sexual *inactivity*, but this point of view is not documented by factual evidence. As many other authors have shown, intertubular material is at a maximum abundance during sexual inactivity, but at this time secretory interstitial cells are absent, these appearing only with the onset of sexual activity.

REPRODUCTIVE DUCTS

In the California Gull it was not possible to preserve and section all parts of the reproductive ducts (rete testis, vas efferens, epididymis, ductus deferens and seminal vesicle), but many of the sections of testes also contained portions of the rete testis and epididymis. At least one sample of these structures was examined for each age group for each month, and, whenever two or more birds of the same age were available, they always had ducts in comparable stages of activity. Microscopic examination revealed histological details essentially similar to those studied and figured by Bailey (1953) in the Oregon Junco.

Several investigators, notably Bailey (*op. cit.*) and Riddle (1927) have shown that these ducts are under androgenic control. They hypertrophy in the breeding season, but shortly thereafter involute to a small and inactive condition in fall and winter. As Bailey demonstrated by laboratory injections in caged juncos, they enlarged under the influence of androgenic substances but not under estrogenic or progestational substances in a manner similar to that found in comparable wild birds of the same species.

Fox (1952) and others have used as a criterion of enlargement actual measurement

of the height of the epithelium of the ducts while Bailey used, in part, weight of the duct section. In the microscopic examination of gull material, the use of relative sizes was found to be sufficient to determine whether or not these structures were active. From Bailey's work the following criteria were adopted.

	Inactive	Active
Rete testis	flattened tubes; epithelium a single layer of closely packed columnar cells.	enlarged tubes; epithelium of flattened to low cuboidal or squamous cells.
Epididymis	circular tubes; practically no lumen; epithelium a single layer of 7–10 wedge-shaped cells.	enlarged tubes; greatly expanded lumen; epithelium pseudostratified ciliated columnar.

There was almost always a direct parallel between the size and activity of the rete testis and that of the epididymis; when one was active and large, so was the other. This would suggest that the other portions of the reproductive ducts which were not examined were in similar condition. As a partial exception to this statement, occasionally a bird with regressing testes in June or July would have one of these structures active while the other was inactive. This condition, however, is plausible since it is perfectly possible and probable that these structures do not enlarge and involute necessarily at the same rate, especially since they are of different sizes. Thus, in figure 1 "activity" and "inactivity" refer to either or, more frequently, to both rete testis and epididymis. Even in the absence of precise measurements, it was possible to recognize readily an intermediate condition which has been termed "half active." This condition of approximately one-half enlargement was especially apparent in first- and second-year birds in May.

The graph of duct activity (fig. 1) shows the same general trend described by Bailey and Bullough in their respective studies, at least as far as third-year and adult birds are concerned. If one assumes the same endocrine-target organ relationship in this gull that Bailey demonstrated in the juncos, then it can be stated that during the breeding season in these two age groups there is an increase in androgen output with a resulting increase in size and activity of the reproductive ducts. Furthermore, there is good evidence from the number of adult interstitial cells present and from soft-part colors that in first- and second-year birds there is enough androgen production to bring these ducts into a partly active state.

As I have indicated, when testes are regressing in size, there is some variation in activity of the reproductive ducts from one bird to another of the same age group, this being especially true of postbreeding adults. On June 19 and 20, 1953, for example, of seven adult males examined (left testis ranging from 104 to 321 $mm.^3$), two had ducts in the active state, one was half active, and four were inactive. By the end of July, however, when regression is essentially complete, all adults have inactive, small ducts. There is a general, though by no means absolute, correlation between size of the regressing testis and size of the ducts: testes below 200 $mm.^3$ usually are associated with inactive ducts.

HISTOCHEMICAL TESTS

Recently, histochemical methods have been utilized to localize the sites of production of the male sex hormone. A review and critique of these methods can be found in the paper by Deane and Seligman (1953). Even though the results at present may not be entirely conclusive in all instances, the gull material was subjected to two techniques in an attempt to demonstrate by color reactions that the interstitial cells are producing androgens at least at some time during the annual cycle.

The 2,4-dinitrophenylhydrazine reaction.—This test has been modified from its original form and described in detail by Albert and Leblond (1946): It is based upon the formation of yellow hydrazones by treating the tissue with 2,4-dinitrophenylhydrazine. Various investigators (for example, Pollock, 1942) prior to Albert and Leblond had used this same general reaction to demonstrate the presence of ketosteroids in parts of the mammalian adrenal cortex, interstitial cells of the testis, parts of the ovary, and the human placenta.

Tissues should be fixed in 10 per cent neutral formalin, but all the gull testes were routinely fixed in nonneutralized (acidic) formalin. Thus, it was necessary to determine at the outset whether or not the difference in pH might give different results. The right testis from a laboratory mouse was fixed in neutralized formalin while the left testis was placed in nonneutralized formalin. Frozen sections of both testes were cut, and these were treated with 2,4-dinitrophenylhydrazine. Both gave the same strong positive reaction (intense yellow color imparted to granules and/or droplets in the interstitial cells; no localized color in tubule constituents). Routinely using the mouse testis fixed in nonneutralized formalin as a control, the test was then conducted on selected gull testes.

The mouse testes had been in the fixative for at least one month, but the period of fixation for the gull testes was from seven to twelve months. This variation in the method may not be important, inasmuch as Ashbel and Seligman (1949:567) indicated with a related technique that apparently a duration of fixation from several hours to several months did not affect the results.

All the gull testes selected for this test were from the right side of adult birds, one taken each month from February through May. This sample was intended to include testes in all spermatogenic stages, from minimum to maximum volumes, and with various numbers and activity of adult interstitial cells. Within this one age group, this sample should have included birds with minimum to maximum androgenic titers. The results of this test on gull testes were negative throughout whereas positive reaction was seen in the mouse material.

Few published data are available for this test on avian testes. Levine (MS) applied the technique to about 30 species of birds from California; this sample included breeding and postbreeding adults and immature birds. The results on testes were mostly negative with the highly dubious exception of two birds which were classed as weakly positive. Arrington, Fox, and Bern (1952), working with chick and sexually mature rooster testes, reported a slightly positive reaction for the chick and a strongly positive reaction for the rooster. In both of these studies, however, I would disagree that positive reactions were obtained. To date, we must conclude that no one yet has satisfactorily demonstrated the presence of ketosteroids in the avian testis with this technique.

The hydrazide-tetrazonium reaction.—Since the development of the dinitrophenylhydrazine test, considerable question has been raised by various workers as to its specificity. In order to improve upon the sensitivity of the colored hydrazine reaction, Ashbel and Seligman (1949) synthesized new compounds and devised a new method which depends upon the coupling of a hydrazide with a tetrazonium compound. The dinitrophenylhydrazine reaction had already been used to demonstrate the presence of carbonyl groups of ketosteroids in various endrocrine glands, and Ashbel and Seligman, using the new technique, were able to duplicate these results. The testes of a rat, rabbit, and dogs were stained for the lipoidal carbonyl groups with the result (positive reaction) that fat droplets in the cytoplasm of the interstitial cells stained blue. The nucleus was unstained and was outlined by the surrounding blue droplets.

Before the gull testes were subjected to this test, laboratory mouse testis was again

run as a control. Positive results resembled those figured in color by Ashbel and Seligman (1949: fig. 2). Comparable positive results on the mouse testis were obtained by using either their original method or by a shorter modification described by Deane and Andrews (1953). Selected gull right testes were then run concurrently with the mouse material (control) using the short method. A larger series (19) of gull testes was used than in the previous test: a representative was taken from each age group in order to cover, as far as possible, the entire range of important spring cyclic events, that is, from the winter inactive condition through gonadal recrudescence to the beginning of regression of the testes. The results of this test for the gull testes were all negative, even though the control mouse material was always positive.

The same test has been applied to a number of vertebrates by Ashbel, Cohen and Seligman (1951). Various vertebrates (frog, rat, mouse, and other mammals) showed a positive reaction in the interstitial cells, but only a few, such as the pig, showed positive Sertoli cells. Their results were negative for two adult roosters taken in August. The only positive reaction obtained was a sudanophilic test on the interstitial cells. Since roosters are not necessarily cyclic, it is difficult to understand why they were negative, for the ketosteroid test with all the other vertebrates was positive. Other investigators, such as Marshall (1949), have also demonstrated that adult functional avian interstitial cells are positively sudanophilic.

As in the dinitrophenylhydrazine reaction, it is necessary to conclude here that positive histochemical evidence for the presence of ketosteroid in the avian testis is lacking.

INCUBATION PATCHES AND SUBADULT BREEDING OF MALES

None of the first- or second-year birds which were collected at Mono Lake ever possessed incubation patches, and, since this structure was an adequate criterion of breeding, it is safe to state that birds of these two age groups do not breed at this colony. Furthermore, there is no evidence in the literature that they breed at any other colony.

The situation in third-year males is complicated by the fact that some birds breed while others do not. From May 15 to 17, 1953, all adults had three well-developed incubation patches. During the same period, three third-year males had incubation patches while three did not. One of the males which had these structures was shot as it incubated two eggs (two- and three-day-old embryos); all the other birds were collected as they flew over the colony.

From May 29 to 30, 1953, again all adults had incubation patches. Of six third-year males, four had these structures. Three of them had incubation patches that were noticeably smaller than those of adults collected on the same day. On June 19, 1953, all adults had refeathering incubation patches, and similar structures were found in one out of two third-year males. These records indicate that more than one-half of the third-year males collected in May and June at Mono Lake possessed incubation patches and were undoubtedly breeding.

Considering the fact that some third-year males develop incubation patches while others do not and the fact that their patches are frequently smaller than adults', it is probable that there are different hormone titers in different third-year males. This belief stems primarily from the investigation of Bailey (1952) on the incubation patch of birds. In adult California Gulls he found that nonbreeding, premigratory birds of both sexes in April had virtually no prolactin in their pituitaries, but at the height of the breeding season in May they showed a much greater prolactin content. Further experimentation proved that both prolactin and estrogen are necessary for the formation of the incubation patch and that nonbreeding birds will develop this structure if these two hormones are injected. Thus, in the third-year gulls of the present study we can postu-

late that one or both of these hormones are at subthreshold level in those birds which do not breed and that breeding third-year birds elaborate threshold quantities but still in varying amounts so that different sizes of incubation patches result.

The evidence from other gulls shows that only a limited number of subadults breed in some species. This has been demonstrated for the Herring Gull, *Larus argentatus* (Gross, 1940; Lincoln, 1928) and the Black-headed Gull, *Larus ridibundus* (Steinbacher, 1936; Kirkman, 1937). It is likewise true of these and other species, for example, the Little Gull (*Larus minutus*), that subadults may return to the breeding colony and yet not breed (Brouwer and Haverschmidt, 1942). In fact, Tinbergen (1936) observed that immature Herring Gulls may pair, build a nest and copulate, but still fail to lay eggs.

The phenomenon of nonbreeding subadults is described for several species of sea birds by Wynne-Edwards (1939). In certain species, such as the Gannet (*Moris bassana*), Kittiwake (*Rissa tridactyla*) and Fulmar (*Fulmarus glacialis*), some or all of the subadults may return to the breeding colonies and yet not breed. Although he believes that most subadult Pomarine Jaegers (*Stercorarius pomarinus*) do not return to the breeding colonies but remain on the wintering ground several thousand miles to the south, the recent work of Pitelka, Tomich, and Treichel (1955), has shown that many subadults of both sexes may be found breeding at Barrow, Alaska. The breeding pair might be composed of two subadults, one subadult and one adult, or two adults.

THE OVARY

In previous studies of avian reproductive cycles, few data have been present for female birds of wild species. Some investigators, however, have shown that females undergo cyclic changes in the ovary and associated structures which are as striking and significant as the better-known cyclic changes in the male system. Notable among these have been Bullough (1942) and Stieve (1919), both of whom emphasized microscopic aspects of the ovary, and Paludan (1951) who concentrated on macroscopic observations as correlated with breeding biology. In the present work on the California Gull (*Larus californicus*) the data amassed for females, although somewhat less complete than those for males, revealed cyclic phenomena that were roughly comparable to the male cyclic events. The general features of the breeding cycle at the Mono Lake colony in California in 1952 and 1953 have already been described and diagrammed (Johnston, 1956: fig. 1).

In the California Gull the ovary varies in size from season to season primarily due to the growth and enlargement of the follicles. During the nonbreeding months for all age groups, the ovary was 12 to 17 mm. long and 6 to 11 mm. wide. There was some tendency for birds in the first-year plumage to have smaller ovaries than those of older birds, but the difference was not significant or constant. The ovary varied from a white or pinkish L-shaped organ to a flat, elongate body. Due to these irregularities in size and shape, volumetric determinations based on measurements comparable to those carried out on testes were impossible, and weights of the organs were not taken. Seasonal variation and development of the ovary, therefore, were based on the size of the largest follicle as determined by caliper measurements, along with partly subjective observations on size and activity of the associated oviduct and, when available, information on incubation and incubation patches. A similar method was employed by Bullough (1942: 199 ff.) except that his study was almost entirely microscopic in nature; most of his measurements were made of oocyte diameters taken with an ocular micrometer from prepared sections of the ovary.

Unless otherwise specified in the discussion to follow, all birds taken during the

breeding season were collected at random as they flew over or near the breeding colony, and, where general references are made to breeding, these are based on average conditions for the entire breeding colony and not for a specific bird.

A summary of seasonal follicular development for all age groups is presented in figure 2. Throughout the entire first year, all follicles were less than 1 mm. The absence of any enlarged follicles, especially during the breeding season, was noticeable. Toward

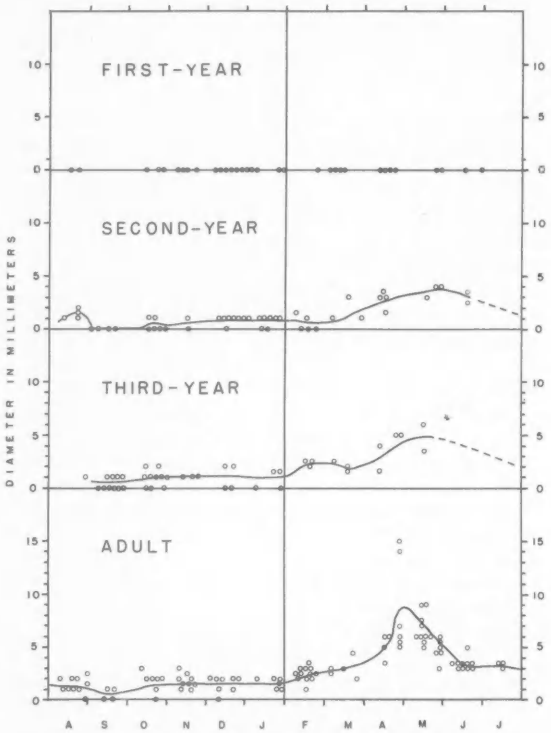

Fig. 2. Cycle of maximum follicle size. Solid line represents mean value; broken line, suggested trend.

the end of the second summer and early fall, however, there was a tendency for follicles to become larger, so that during the second winter a mean follicle size of 1 mm. was achieved which differed noticeably from the condition found in first-year birds in the same month. Beginning about the end of March in second-year birds, there was a gradual increase in size of follicles until a mean maximum of 3.5 mm. was reached about June 1. Since no second-year females were obtained in late April and early May at the breeding colony, it is possible that some birds might have had larger follicles in this period, but my data for late May are not significantly different from comparable data on birds taken in early and mid-May at Great Salt Lake, Utah. After June 1, these somewhat enlarged follicles apparently become atretic so that, by the end of August,

birds now in the third-year plumage had follicles of only about 1 mm. There was no evidence that the relatively few first- and second-year females that were collected at the breeding colony ever bred.

During the third winter the mean maximum follicle size was about 1 mm. and thus was similar to conditions found in second-year birds, although there was some tendency for follicles to be larger. Only an occasional winter second-year bird had a follicle which was over 1 mm., but several third-year birds had follicles up to 2 mm. Whereas spring enlargement of follicles in second-year birds began in late March, in third-year birds there was a considerable upswing of follicle size in mid-February. This growth of follicles continued until a mean maximum of 5 mm. was reached at the end of April. No third-year females were obtained in June or July.

Adult birds (this group included birds which had just molted from third-year to adult plumage) that had recently returned to the San Francisco Bay area in August had ovaries in an inactive condition, the mean maximum follicle size being about 1.5 mm. There was a general tendency for follicles in winter adults to average 1.5 to 2.0 mm.; thus they were somewhat larger than in birds of other age groups at this time of year. As in third-year birds, there was a noticeable average increase in activity of the ovary and follicular development in mid-February, with the curve of follicle size rising abruptly to a mean of about 8 mm. at the end of April on the breeding grounds.

On April 28, 1953, two of several adults collected had follicles which measured 14 and 15 mm., respectively. One of these birds had three follicles of 7 mm., and the other had several 6 mm. follicles. At this time no nests had been constructed at the colony and most birds had no trace of an incubation patch. At the time in the field, I thought that these largest follicles were about to be ovulated, but subsequent consideration has shown that such a view may be wrong. In the first place, in the Herring Gull, admittedly a somewhat larger bird, Paludan (1951:73) found that an adult fully two days before laying its first egg had follicles 36, 32, 27 and 19 mm. In the second place, the work of Bailey (1952:125) and others has indicated that defeathering for the incubation patch generally occurs several days before the first egg is laid. In only one of these two gulls was there even a trace of defeathering. Probably ovulation was still several days off. The mean maximum follicle size, therefore, given for adults in the breeding season should probably be much greater.

In 24 adult females collected in the breeding period at the end of April and during May, it was possible only rarely to observe recently ovulated or collapsed follicles, but my failure to observe more of these was due in part to my absence from the colony when most of the eggs were being laid in early May. It was impossible to check the nest contents of most of the birds collected, but the following females were shot from nests the contents of which were then examined and were correlated with reproductive condition:

May 15, 1953	3 collapsed follicles, others up to 6 mm.	incubating 2 eggs, 2 days old
May 15, 1953	1 collapsed follicle, others up to 7.5 mm.	incubating 2 eggs, 2 days old
May 15, 1953	2 collapsed follicles, others up to 7 mm.	incubating 2 fresh eggs
May 29, 1953	no collapsed follicles, others up to 4.5 mm.	incubating 2 eggs, 3 weeks old
May 29, 1953	no collapsed follicles, others up to 3 mm.	incubating 3 eggs, 3 weeks old
May 29, 1953	no collapsed follicles, others up to 5.5 mm.	incubating 3 eggs, 2 weeks old

From these data it would appear that ovulated follicles were resorbed rather rapidly, probably within a week, even though some enlarged follicles were still present. This subject has been treated in detail by Paludan (1951:49) who noted that the Herring Gull had no collapsed follicles visible on the surface of the ovary nine days after the last egg was laid, and by Stieve (*fide* Paludan, *op. cit.*: 57) who reported that some follicular degeneration began after the second egg was laid in the Jackdaw (*Corvus monedula*). On the other hand, some follicles showed no signs of degeneration even after four weeks of incubation by the female. In the British Starling, Bullough (1942:207–209) found microscopically what he has called corpora lutea in both first-year and adult birds; these persisted for about two months after incubation.

SIZE AND ACTIVITY OF THE OVIDUCT

There is a direct correlation between size and activity of the oviduct and the development of the follicles. During the winter months in all age groups the oviduct remained small and inactive. Toward its proximal end it always measured less than 1 mm. in width. In the first breeding season, there was only a slight enlargement to 1.5 or 2.0 mm., but there were no signs of reproductive activity. This condition of the oviduct was the same for birds in their second breeding season even though some of these birds had somewhat enlarged follicles at this time.

In the third breeding season, at the end of April, there was an enlargement of the oviduct to 3 mm. in width, this being true of birds the ovaries of which contained follicles up to 5 mm. in diameter. This was the most advanced condition discovered in any third-year females at any time in the breeding season.

As in the case of mean maximum follicle size, in breeding adults there was a rather abrupt enlargement of the oviduct following the inactive winter condition, and at the same time it became more convoluted and twisted. On April 27 and 28, 1953, oviducts varied from 2 to 6 mm. in width, a variation which was correlated with maximum follicle size and development. On these days birds with the smallest follicles (maximum 5 to 7 mm.) had the least developed oviducts (2 to 4 mm.). The two adults which had the largest follicles had oviducts 6 and 7 mm. wide, the greatest width found in any birds collected.

In the middle of May, after adults were incubating eggs, there was a noticeable collapse and subsequent regression of the oviduct, although an occasional bird continued to show near maximal development. By the end of May when most of the eggs were at least two-thirds incubated, most of the birds had oviducts which had diminished to 3 or 4 mm., and this size was maintained as an average condition throughout June and July. Adults recently returned to the San Francisco Bay area in August had oviducts in the small, inactive condition. A similar cycle of enlargement and regression of the oviduct, in conjunction with follicular development and the breeding season, was demonstrated in the adult British Starling by Bullough (1942:209–212).

Several investigators have shown that the hypertrophy of the oviduct in birds in the breeding season is under the control of estrogenic substances. Under natural conditions, Keck (1934) showed that the maximal development of the oviduct in the English Sparrow (*Passer domesticus*) coincided with maximal development of the ovary in the breeding season, and then by injection of female sex hormone he was able to bring inactive oviducts into a breeding condition. Such results have also been demonstrated in doves by Riddle and Tange (1926).

INCUBATION PATCHES IN FEMALES

Incubation patches, when functional, were considered as evidence for breeding second only to the taking of an incubating bird from a nest. At no time was an incubation

patch found in any first-, second- or third-year females, even when some of these birds were collected at the height of the breeding season at the breeding colony. However, all adult females, collected during May and early June at the colony, with the exception of a single bird on May 16, 1952, had three well-developed incubation patches, two anterolaterally, and one central and posterior. The first indication of defeathering for the incubation patch was seen on one adult female on April 28, 1953, a bird with a 14 mm. follicle. On the same date, other adults, one with a 15 mm. follicle, had no patches.

In spite of the fact that the mean clutch size was about two, all adults, both males and females, always had three incubation patches, and there was no apparent difference in the functional condition among the various patches in the adults, even though a bird might be incubating only two eggs. It would seem that the hormonal regulative system for this structure provides a margin of safety, as it were, in case more than two eggs are incubated.

NONMIGRATORY FEMALES

Only a small sample of nonmigratory birds was obtained during the breeding months away from the breeding colonies. The data on maximum follicle size in nonmigratory females are presented in table 1. Because of the small sample, one can draw only tentative conclusions. In the first place, it must be noted that, with one possible exception, no adult females were ever collected away from the breeding colony, but undoubtedly some adult females fail to return to the breeding colonies because occasional adults may

Table 1

Maximum Follicle Size of Nonmigratory Birds

Date	First-year	Second-year	Third-year	Adult
May 6, 1953			3	
June 4, 1952	2			
July 6, 1953		2		
July 8, 1952	<1			
July 21, 1952		2		
July 30, 1952[a]			2	1.5

[a] Possibly newly arrived migrants.

be found in the San Francisco Bay region in the summer months. In the second place, if these data are compared month for month with the data presented for birds of the same age group collected at Mono Lake (fig. 2), it will be seen that there are no significant differences in maximum follicle size, although the sample size is small. None of the nonmigratory birds had an enlarged oviduct or incubation patch.

In subadult females there are no differences in follicle size between migratory and nonmigratory birds; it should be recalled that such was not the case in males. This is further indication that males of this species tend to mature sooner than do females.

BREEDING STATUS OF SUBADULT FEMALES

There has been some discussion in the literature of the breeding status of birds in the third-year plumage, and Behle and Selander (1953:253–254) present evidence that some females do breed in this plumage. Actually there is only one unequivocal record among their data, namely, a female with a 15 mm. follicle and an enlarged oviduct taken at Great Salt Lake in early May, 1952. The mere presence of a bird at a colony is not final proof of breeding, even though it might be a male with spermatozoa. Aside from

collecting a bird from an occupied nest, and not merely in the vicinity of a nest or young, the essential morphological criterion of breeding should be the presence of a functional incubation patch, a structure which is not universally present in third-year birds of either sex.

The small number of records presented by these workers (table 7, p. 251) on largest follicle size of third-year females is likewise inconclusive evidence for breeding, because the birds were past the egg-laying period, and, except for the one bird with the 15 mm. follicle, these birds do not differ in follicle size significantly from unequivocal nonbreeding second-year females collected on the same day.

As Behle and Selander found at the Great Salt Lake colony, at Mono Lake only a small percentage of third-year birds were females. At Great Salt Lake the ratio of birds in this age group collected flying over the colony was 43 males:4 females; at Mono Lake this ratio was 29:4. This fact alone would naturally decrease the possibility of obtaining a breeding female of this age group. These authors speculated that perhaps the immature females might be in the region but not at the nesting colonies. Although this might be true at other colonies, it was not true near Mono Lake. A careful search was made of lakes, streams and small-town garbage dumps near Mono Lake in the breeding seasons of 1952 and 1953, and, aside from obviously migratory birds, no individuals or groups of nonbreeders were ever located.

Although I was successful in collecting an incubating third-year male, no females of this age group were ever collected on or even near nests. This fact agrees with the data of Behle and Selander who correctly averred that the preponderance of third-year males over females, taken as flying birds over or near the colony, could not be attributed to the fact that females were incubating elsewhere.

One would expect that third-year females would have follicles about as large as those of the adults if they were breeding or were about to breed; at least this was what Bullough (1942: table 6, p. 200) found in the British Starling. Such was not the case, however, in third-year California Gulls (see fig. 2). All of these facts lend further support to the conclusion that very few of the third-year females breed.

As has been mentioned previously in connection with the cycle of the male, breeding of subadults in other species is a fairly widespread phenomenon. For many species in which sexual maturity is reached in less than one year, this is probably a nearly universal situation, but in others, in which age groups are recognizable by different plumages during the breeding season, as in gulls, it is not so universal (see Mayaud, 1941). It is worth noting, however, that Mayaud reported female Black-headed Gulls (*Larus ridibundus*) breeding in the first-year plumage. Since sexual dimorphism is absent in this species, one must assume that the birds were collected. Noll (*fide* Mayaud) believed that precocious sexual development in this species was limited to the females, but in the California Gull it is the male which is somewhat more sexually precocious.

In the British Starling, Bullough (1942:199–214) found that during the nonbreeding months the mean of maximum oocyte diameters of first-year birds was smaller than that of adults, but during the breeding months there was no significant difference between the two groups. This was due to the fact that subadult females, as in most passerines, breed in their first spring. Hiatt and Fisher (1947:538–540) reported that in the Ring-necked Pheasant there was no evidence of oogenesis in juvenal birds in the fall although there is development of the testes in males. However, both adults and first-year females in the spring showed a trend of follicular enlargement similar to that found in the adult gulls.

SUMMARY AND CONCLUSIONS

The California Gull belongs to that group of the Laridae in which four age groups may be distinguished on the basis of plumage, colors of soft parts, and length of the bursa of Fabricius (see Johnston, 1956). These groups are first-year, second-year, third-year, and adult. The sequence of molts, plumages and age groups has been recently confirmed by banding nestlings and recovering them in subsequent years. This has made it possible to relate age group to reproductive condition and migration.

During the winter birds of all ages and both sexes are in a quiescent reproductive state, but in the spring various changes ensue. In migratory birds, first-year males show virtually no enlargement of the testes in the spring, second-year birds' testes enlarge to about one-fourth of the adult maximum size, and those of third-year birds enlarge to about one-half of the adult size. The maximum testis volume is reached in adult males at about the time the eggs are laid, and the testes begin to regress immediately thereafter. Spermatogenic activity is correlated with the size of the testis since first-year birds do not develop beyond the primary spermatocyte stage whereas most of the second-year and all third-year and adult birds produce spermatozoa. Males which do not migrate have, for the most part, significantly smaller testes than those which move to the breeding grounds, but spermatogenic activity of the small sample was apparently not significantly different from that of birds of the same age group which had migrated except for the fact that no mature spermatozoa were ever detected in the nonmigrants' testes.

A somewhat parallel condition to testis enlargement is the increase in number of mature interstitial cells and increase in size of the reproductive ducts, the most advanced condition being found in adults at the height of the breeding season. The enlarged ducts are attributed to the effects of heightened androgenic titers as a result of increased activity of the enlarged, more numerous interstitial cells. Enlarged reproductive ducts are found just after the mature interstitial cells reach their peak in numbers, indicating a lag between supposed androgen production and the effect on the target organ.

In an attempt to localize possible areas of androgen production cytochemically, frozen sections of testes from gulls in various reproductive conditions were subjected to two histochemical tests, both of which proved to be negative even though mouse material run simultaneously was positive for the interstitial cells. Thus, to date no one has satisfactorily demonstrated the presence of ketosteroids in avian testes by utilizing histochemical procedures.

By the use of reproductive stage of the gonads and the presence or absence of incubation patches, it has been demonstrated that no first-year or second-year birds of either sex breed. No third-year females were found breeding at the Mono Lake colony, but occasionally they do so at other colonies. About one-half of the third-year males were found to have incubation patches, and these were believed to be breeding. Seventy-seven out of 78 adults developed incubation patches during the breeding season, thus providing evidence that virtually all adults breed .

In females, no follicles enlarged beyond 6 mm. were found except in adults just prior to egg laying, thus providing further evidence that subadult females rarely if ever breed. Subadult females which did not migrate to the breeding colony have smaller follicles than adults, but these are not significantly different from those of migratory subadults.

There is a tendency for the younger age groups to remain away from the breeding grounds, whereas virtually all adults migrate to breeding colonies in the spring. Thus, at the breeding colonies there are fewer of the successively younger age groups. These data suggest that in some fashion adults respond most highly to migratory stimuli, but, since some subadults do migrate, there must also be a differential response on the part of different individuals within a given subadult age group.

The bill, leg, eyelid, and gape show seasonal or cyclic enrichment of colors, conditions which are attributable to increased androgen production in the spring. The attainment of the adult plumage in both sexes has been shown by other authors also to be due to these hormones in other species of gulls.

LITERATURE CITED

Albert, S., and Leblond, C. P.
1946. The distribution of the Feulgen and 2,4-dinitrophenylhydrazine reactions in normal, castrated, adrenalectomized and hormonally treated rats. Endocrinology, 39:386–400.

Arrington, L. R., Fox, M. H., and Bern, H. A.
1952. Androgen content of testis and adrenal of white leghorn cockerels. Endocrinology, 51: 226–236.

Ashbel, R., Cohen, R. B., and Seligman, A. M.
1951. Histochemical demonstration of ketosteroids in normal and neoplastic testes. Endocrinology, 49:265–281.

Ashbel, R., and Seligman, A. M.
1949. A new reagent for the histochemical demonstration of active carbonyl groups. A new method for staining ketonic steroids. Endocrinology, 44:565–583.

Bailey, R. E.
1952. The incubation patch of passerine birds. Condor, 54:121–136.
1953. Accessory reproductive organs of male fringillid birds: seasonal variations and response to various sex hormones. Anat. Rec., 115:1–20.

Behle, W. H., and Selander, R. K.
1953. The plumage cycle of the California gull (*Larus californicus*) with notes on color changes of soft parts. Auk, 70:239–260.

Blanchard, B. D., and Erickson, M. M.
1949. The cycle in the Gambel sparrow. Univ. Calif. Publ. Zool., 47:255–318.

Bouin, P., and Ancel, P.
1903. Recherches sur les cellules interstitielles du testicle. Arch. Zool. Exp. et Gén., 31:437–523.
1904. Recherches sur la signification physiologique de la glande interstitielle du testicle des mammifères. Jour. Physiol. et Pathol. Gén., 6:1012–1022.

Brouwer, G. A., and Haverschmidt, F.
1942. Een kleine breedkolonie van *Larus minutus* Pall. in Nederland in 1942. Ardea, 31:157–174.

Bullough, W. S.
1942. The reproductive cycles of the British and continental races of the starling (*Sturnus vulgaris* L.). Philos. Trans. Roy. Soc. Lond., ser. B, 231:165–246.

Deane, H. W., and Andrews, J. S.
1953. A comparison of the staining of lipid droplets in the mouse ovary by the Schiff reaction and by the Ashbel-Seligman carbonyl reaction. Jour. Histochem. and Cytochem., 1:283–295.

Deane, H. W., and Seligman, A. M.
1953. Evaluation of procedures for the cytological localization of ketosteroids. Vit. and Hor., 11:173–204.

Fox, W.
1952. Seasonal variation in the male reproductive system of the Pacific coast garter snakes. Jour. Morph., 90:481–554.

Gross, A. O.
1940. The migration of Kent Island herring gulls. Bird-Banding, 11:129–155.

Hiatt, R. W., and Fisher, H. I.
1947. The reproductive cycle of ring-necked pheasants in Montana. Auk, 64:528–548.

Johnston, D. W.
1956. The annual reproductive cycle of the California Gull. I. Criteria of age and male reproductive cycle. Condor, 58:134–162.

Keck, W. N.
1934. The control of the secondary sex characters in the English sparrow. Jour. Exp. Zool., 67:315–347.
Kirkman, F. B.
1937. Bird behavior. A contribution based chiefly on a study of the black-headed gull (Nelson, London).
Lincoln, F. C.
1928. The migration of young North American herring gulls. Auk, 45:49–59.
Marshall, A. J.
1949. On the function of the interstitium of the testis: the sexual cycle of a wild bird, *Fulmarus glacialis* (L.). Quart. Jour. Micr. Sci., 90:265–280.
Mayaud, N.
1941. Quelques cas de reproduction d'oiseaux sous un plumage immature. Bull. Mens. Soc. Linn. Lyon, 10:61–64.
Oslund, R. M.
1928. Seasonal modifications in testes of vertebrates. Quart. Rev. Biol., 3:254–270.
Paludan, K.
1951. Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. Vidensk. Medd. fra Dansk naturh. Foren., 114:1–128.
Pearson, O. P., Koford, M. R., and Pearson, A. K.
1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. Jour. Mamm., 33:273–320.
Pitelka, F. A., Tomich, P. Q., and Treichel, G. W.
1955. Ecological relations of jaegers and owls as lemming predators near Barrow, Alaska. Ecol. Mono., 25:85–117.
Pollock, W. F.
1942. Histochemical studies of the interstitial cells of the testis. Anat. Rec., 84:23–28.
Riddle, O.
1927. The cyclical growth of the vesicula seminalis in birds is hormone controlled. Anat. Rec., 37:1–11.
Riddle, O., and Tange, M.
1926. Some limitations of the action of the so-called follicular hormone in birds. Proc. Soc. Exp. Biol. Med., 23:648.
Sluiter, J. W., and van Oordt, G. J.
1947. Experimental data on the function of the interstitium of the gonads: experiments with cockerels. Quart. Jour. Micr. Sci. Lond., 88:135–150.
Steinbacher, J.
1936. Zur Frage der Geschlechtsreife von Kleinvögeln. Beiträge zur Fortpflanzungsbiologie der Vögel, 12:139–144.
Stieve, H.
1919. Die Entwicklung des Eierstockseies der Dohle (*Colaeus monedula*). Arch. f. Mikro. Anat., 92:137–288.
Tinbergen, N.
1936. Waarnemingen en Proeven over de Sociologie van een Zilbermeeuwenkolonie. De Levende Natuur.:1–24.
Wright, P. L., and Wright, M. H.
1944. The reproductive cycle of the male red-winged blackbird. Condor, 46:46–59.
Wynne-Edwards, V. C.
1939. Intermittent breeding of the fulmar, *Fulmarus glacialis* (L.), with some general observations on nonbreeding in sea-birds. Proc. Zool. Soc. Lond., 109 (ser. A):127–132.

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THE EFFECT OF DIET ON PHOTOPERIOD-INDUCED LIPID DEPOSITION IN THE WHITE-THROATED SPARROW

By EUGENE P. ODUM and JAMES C. MAJOR

In a previous paper (Odum and Perkinson, 1951) it was shown that White-throated Sparrows (*Zonotrichia albicollis*) undergo two periods of lipid deposition while on their winter range, one during midwinter and the other just prior to northward migration in late April and early May. Between these periods a relatively lean period occurs during the prenuptial molt of March and early April. Actual extractions of lipids from various parts demonstrated that "winter fat" differed in body distribution as compared with "migratory fat," the latter showing a characteristic peritoneal concentration. Wolfson (1945, 1953, 1954) has shown that marked fat deposition can be induced in various migratory fringillids by increased photoperiods, the assumption being that the induced deposition represents the premigratory type. Characteristically, premigration lipid deposition occurs rapidly, the bulk of fatty material often being laid down within a few days. This poses interesting questions in regard to food and water intake.

The experiment described in this paper was designed (1) to compare the lipid deposition of birds on a high fat diet with a similar group on a low fat diet, (2) to determine the amount of food and water consumed by the experimental groups and a control group, and (3) to determine if the fat deposits induced in midwinter by increased photoperiods are quantitatively similar to "migratory fat" which normally occurs in the spring premigration period.

METHODS

White-throats were captured during October and November, 1952, and kept under natural day-length conditions until November 27, which is well beyond the end of the autumn refractory period (Miller, 1948; Wolfson, 1952). The birds were then divided into three groups as follows: group A—12 birds exposed to increased photoperiods and placed on a high fat diet; group B—12 birds exposed to the same increased photoperiods as group A but given a low fat diet; group C—9 control birds exposed to natural photoperiods and fed a mixed diet. Birds of group A were fed on "Pecano" which consists of bits of pecan meats that remain after shelling in pecan packing plants, and which has a lipid content of about 60 per cent. Group B were given unmixed canary seeds which are low in fat, while group C had access to both Pecano and seeds. All three groups were also given Gaines dog meal to insure adequate amounts of minerals and vitamins. The composition of the three food items by per cent was as follows:[1]

	Pecano	Seeds	Dog food
Fat	60	6	7
Protein	10	17	25
Carbohydrate	17	55	48
Fiber	4	5	4
Ash	2	6	8
Moisture	7	11	8
Calories per gram	6.5	3.4	3.5

[1]Analyses of Pecano and seed made by Dairy Nutrition Laboratory, University of Georgia, and dog food courtesy of Gaines Division of General Foods Corporation.

Each group was kept in a separate screen wire cage 3×2½×3 feet. Groups A and B were placed in a small basement laboratory room where they were exposed to daylight plus an extra period of light from a 75-watt bulb controlled by a poultry time switch. Birds of group C were kept in an adjoining room and exposed to normal daylight only.

Control birds, of course, were exposed to naturally increasing photoperiods during the latter half of the experiments, and they also received, inadvertently, some artificial light on several occasions when lights were turned on in the control room at night. Nevertheless, the difference between the response of controls and experimentals was quite marked. Two birds in group A were lost during the experiment and rats killed four birds in group C so that the numbers of birds completing the experiments were 10, 12, and 5, respectively. Birds in each group were nearly equally divided as to sex.

After correspondence with Dr. Albert Wolfson, who very kindly gave us the benefit of his experience in experiments of this type, it was decided to employ a light schedule which would be moderately forcing, that is, one that might be expected to bring about a full response in about two months. Beginning on November 28, when the day-length was 12 hours, 15 minutes of extra light was added daily until a 16-hour day was reached on December 16. This long photoperiod was then continued until the end of the experiment (fig. 1).

At intervals of three or four days birds were weighed in the early evening just after the light went off in the experimental room. Food consumption was measured by placing a known weight of food in each cage and then weighing the food remaining at the end of one to three 24-hour periods. The cages were equipped with hardware-cloth bottoms so that it was possible to recover spilled food in pans under the cages. At best, however, measurements of food consumption were considered to be only approximate. A somewhat more precise measurement of water consumption was made possible with the use of self-feeding water bottles. Hygrothermograph records revealed that the temperature of the laboratory rooms averaged 68°F., varying only between 62° and 72°, while the relative humidity varied between 50 and 80 per cent with an average of about 60 per cent.

At the end of the experiment when a full response in the experimentals had been obtained, as indicated by a marked increase in body weight, all birds were sacrificed. Subcutaneous, peritoneal, and total body lipids were extracted in exactly the same manner as had been done previously with birds from the wild population (Odum and Perkinson, 1951).

RESULTS

Changes in body weight are shown in figure 1. There was an initial drop in body weight in all three groups of birds and then a slight rise. Between January 10 and February 1 birds in the two experimental groups (A and B), in contrast to those in the control group (C), increased markedly in weight. A similar pattern of weight change was obtained by Wolfson (1952) in White-throated Sparrows using a more forcing light schedule (beginning in mid-January) of 5:1, or a continuous photoperiod of 20 hours; in these cases a full response was obtained in about a month as compared with over two months in the present experiment. As indicated in figure 1 both the timing and the amplitude of the response, as far as weight changes were concerned, were similar in groups A and B; birds increased in weight as readily on a high fat as on a low fat diet. However, as will be noted below, group A birds did become a little fatter.

An essentially normal prenuptial molt occurred in both experimental groups coincident with the weight increase as shown in figure 1. No sign of molt was observed in any of the control birds. In nature the prenuptial molt occurs in March or early April prior to the premigration weight increase; that is, birds in nature do not get fat and molt at the same time. In our experiments the birds were able to telescope both of the energy demanding changes when they were subjected to strong light stimulus in the presence of abundant food which could be obtained with a minimum of exercise. Farner

and Mewaldt (1955:115) also report that "molt and weight responses, which are sequential under natural conditions in spring, can develop simultaneously under experimental conditions" in the White-crowned Sparrow (*Z. leucophrys gambelii*). It should be borne in mind that we are here considering the prenuptial molt, which is a partial molt involving the body but not the flight feathers, and not the complete postnuptial or annual molt which normally occurs, or may be experimentally induced, on short or decreasing photoperiods (Lesher and Kendeigh, 1941).

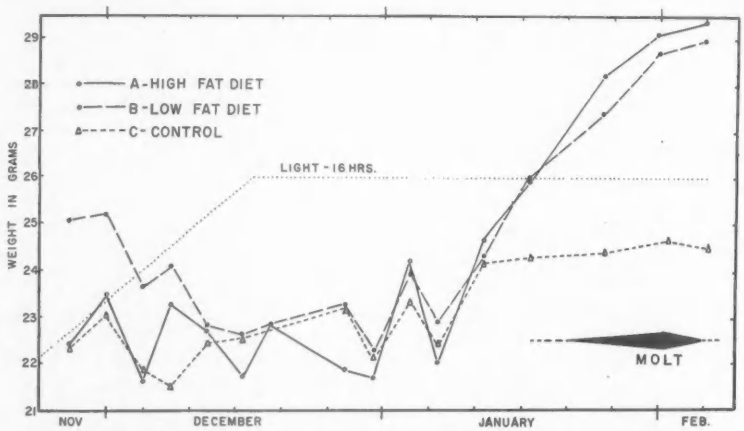

Fig. 1. Changes in weight of two experimental groups and one control group of White-throated Sparrows. Light schedule and time of molt for experimental groups shown.

It would appear that physiological changes which occur prior to northward migration do not represent chain reactions in the sense that one change (molt) must necessarily precede another change (fat deposition). It may be a matter of different hormone thresholds, the molt occurring at a lower level of pituitary stimulation. In wild birds once the molt is underway, the fat deposition might well be delayed because of the energy demands of feather growth even though the threshold for fat deposition had been reached in the meantime. This might explain why fat deposition in wild birds begins so rapidly after the molt is completed.

In nature, males increase in weight sooner than and migrate ahead of females by as much as two weeks (Odum, 1949). In figure 2 the average weights of the 11 males and the 11 females which made up the two experimental groups are shown. Weight changes in the two sexes, throughout the two and a half month experiment, almost exactly paralleled each other, but males reached the peak a few days before the females. Thus, even with the forcing light schedule the difference in response between the sexes is evident.

The lipid levels of experimental and control birds are compared with those of wild birds in table 1. It is evident that birds subjected to increased photoperiods very closely resembled normal premigratory birds both in the total amount of fat and its distribution within the two major deposits. This was especially true of birds in group A, which accumulated a somewhat larger total amount of fat than birds on the low fat diet. The difference in subcutaneous lipids of the two experimental groups was significant at the 95 but not at the 99 per cent level while differences in abdominal lipids were not significant (table 2).

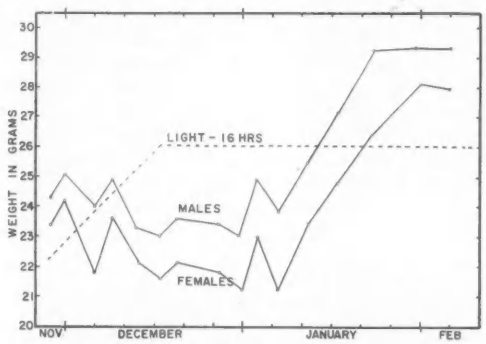

Fig. 2. Comparison of weight changes of 11 males and 11 females from the two experimental groups subjected to long photoperiods as shown.

Normal winter birds accumulate considerable fat in the subcutaneous region but comparatively little in the abdominal region (see table 1). Note that both groups of experimental birds had the characteristic concentration of abdominal lipids of normal premigratory birds. Control birds, on the other hand, resembled normal winter birds in having a low percentage of abdominal fat, and they were also less fat generally.

Table 1

Extracted Lipids in Grams in Experimentally Induced Lipid Deposition as Compared with Seasonal Variation in Wild Birds

	No. birds	Average body weight	Subcutaneous lipids	Per cent body weight	Abdominal lipids	Per cent body weight	Total lipids	Per cent body weight
Wild Series[1]								
Post migration (fall)	23	26.3	0.615	2.34	0.118	0.45	1.804	6.88
Winter	15	29.9	1.551	5.19	0.266	0.89	3.608	12.05
Molt (early spring)	27	27.1	0.597	2.20	0.097	0.36	1.688	6.25
Premigration (late spring)	19	30.4	2.076	6.83	0.599	1.97	4.806	16.66
Experimental Series								
A (high fat diet)	10	29.4	2.156	7.33[2]	0.663	2.25[3]	4.911	16.70
B (low fat diet)	12	29.0	1.614	5.57[2]	0.624	2.15[3]	4.266	14.71
C (control)	5	24.8	1.029	4.15	0.240	0.97	2.594	10.46

[1] Data from Odum and Perkinson (1951) table 2.
[2] Difference between A and B significant at 95 per cent level ($T = 2.28$; $P = 0.04$).
[3] Difference between A and B not significant.

It appears from these data that the normal spring premigratory deposition was quantitatively duplicated in amount and body distribution by the manipulation of the single environmental factor, namely light, and that the amount of fat in the diet had little effect on the magnitude of the deposition. A high fat diet did not cause the birds to become any fatter than normal premigratory birds in nature.

The caloric value of food consumed during the experiment is shown in table 2. No correction has been made for unmetabolized food in the excreta. In a later experiment

it was found that food utilization efficiency did not differ between the two diets. In the experimentals, average calories used per bird per day paralleled changes in weight (compare fig. 1 and table 2). The first increase in food consumption coincided or slightly preceded the first evident increase in weight, and the maximum food consumption occurred during the period of rapid increase in weight between January 10 and 30. It is also evident from table 2 that birds in group A consumed more energy than birds in group B. However, birds of group B started at a lower level at the onset of the experiment so that the rate of increase was about the same for both groups.

Table 2

Food Consumption in Calories per Bird per Day

	Series A Increased photoperiod, high fat diet	Series B Increased photoperiod, low fat diet	Series C (control) Normal photoperiod, mixed diet
Nov. 27–Dec. 5	17.8	14.2	13.6
Dec. 5–Dec. 11	14.0	11.4	14.6
Dec. 11–Dec. 18	11.5	12.3	12.6
Dec. 18–Dec. 24	16.9	14.0	12.9
Dec. 24–Dec. 31	19.4	14.6	15.1
Dec. 31–Jan. 7	24.3	18.3	15.8
Jan. 7–Jan. 12	22.0	18.1	16.5
Jan. 12–Jan. 18	26.0	18.4	17.1
Jan. 18–Jan. 25	24.8	19.6	17.9
Jan. 25–Jan. 30	26.1	25.0	18.0
Jan. 30–Feb. 4	22.8	22.4	17.1
Feb. 4–Feb. 8	23.3	18.5	17.6
Average	20.7	17.2	15.7

Water consumption during the experiment is summarized in table 3. In both experimental groups, in contrast to controls, there was an increase in water consumption, especially after fat deposition was well underway. The increase was more marked in birds on the high fat diet. The increase in water is presumedly related to the need for increased heat loss as birds become enveloped in a blanket of fat, especially since they were confined to cages in a relatively warm room.

It is well known that in rats certain hypothalamic lesions, which may be experimen-

Table 3

Water Consumption in Milliliters per Bird per Day

	Series A Increased photoperiod, high fat diet	Series B Increased photoperiod, low fat diet	Series C (control) Normal photoperiod, mixed diet
Nov. 29–Dec. 8	9.9	8.8	10.0
Dec. 8–Dec. 15	10.2	8.4	11.5
Dec. 15–Dec. 20	11.5	8.4	
Dec. 24–Jan. 1	8.1	10.0	12.7
Jan. 1–Jan. 6[1]	14.8	13.5	14.2
Jan. 6–Jan. 12	15.6	12.1	
Jan. 12–Jan. 22	13.2	12.8	12.1
Jan. 22–Jan. 31[2]	17.4	14.4	10.7
Jan. 31–Feb. 8[3]	27.5	17.3	13.2

[1] First evidence of increase in weight in experimentals.
[2] Rapid increase in weight in experimentals.
[3] Maximum lipid deposition in experimentals.

tally produced, cause the animals to become very obese. Appetite and food consumption increase, but Brobeck (1946) reports that even when food is restricted to that used by the normal rat the experimental rats may still get fat. He suggested that the habit of eating rapidly and a reduction in heat production allows conversion of more food energy to fat. Since water consumption increased in our experiment on birds, it might be assumed that heat production energy was not diverted into fat since birds were having to take more water to get rid of excess heat. A logical follow-up experiment, of course, would involve restricting food to 15 calories per bird per day, applying increased photoperiods, and then observing whether the birds were able to accumulate fat.

SUMMARY

An experiment was designed to compare photoperiod-induced lipid deposition of birds on high fat and low fat diets, to determine food and water consumption, and to determine if induced fat deposits are quantitatively similar to normal premigratory deposits.

Beginning in late November two groups of White-throated Sparrows, one on a high fat diet (pecans, 60 per cent fat) and the other on a low fat diet (seeds, 6 per cent fat), were subjected to gradually increased photoperiods up to 16 hours. A third, or control, group on a mixed diet was subjected to normal late fall and early winter photoperiods.

Both groups of experimental birds, in contrast to controls, increased markedly in weight between January 10 and February 1 while at the same time undergoing a prenuptial molt, demonstrating that these two energy-demanding events, which occur separately in nature, can be telescoped under conditions of forcing stimuli and ample food (fig. 1). Males increased in weight sooner than females as is normal in the field in spring (fig. 2).

The lipid levels in experimental birds sacrificed when maximum weight was obtained were very similar to normal premigratory birds (Odum and Perkinson, 1951) both as to total amount of fat and its distribution between subcutaneous and abdominal deposits. Controls resembled normal winter birds. Birds on the high fat diet accumulated somewhat more subcutaneous fat and more closely resembled normal premigratory birds than did those on the low fat diet. It is concluded that the normal spring premigratory deposition was quantitatively duplicated by the manipulation of the single factor of light and that the amount of fat in the diet had but little effect on the magnitude of the deposition (table 1).

Food consumption, calculated as calories consumed and uncorrected for fecal loss, in the experimentals increased from 11 to 17 calories per bird per day up to as high as 26 calories during the period of most rapid weight increase and molting (table 2).

Water consumption in experimentals increased rather markedly during the last stages of weight increase, especially in birds on the high fat diet, presumably due to the increased need for internal heat loss (table 3).

LITERATURE CITED

Brobeck, J. R.
1946. Mechanism of the development of obesity in animals with hypothalamic lesions. Physiol. Revs., 26:541–559.

Farner, D. S., and Mewaldt, L. R.
1955. The natural termination of the refractory period in the white-crowned sparrow. Condor, 57:112–116.

Lesher, S. W., and Kendeigh, S. C.
1941. Effect of photoperiod on molting of feathers. Wilson Bull., 53:169–180.

Miller, A. H.
1948. The refractory period in light-induced reproductive development of the golden-crowned sparrow. J. Exp. Zool., 109:1–11.
Odum, E. P.
1949. Weight variations in wintering white-throated sparrows in relation to temperature and migration. Wilson Bull., 61:3–14.
Odum, E. P., and Perkinson, J. D., Jr.
1951. Relation of lipid metabolism to migration in birds: seasonal variation in body lipids of the migratory white-throated sparrow. Physiol. Zool., 24:216–230.
Wolfson, A.
1945. The role of pituitary, fat deposition, and body weight in bird migration. Condor, 47:95–127.
1952. The occurrence and regulation of the refractory period in the gonadal and fat cycles of the junco. J. Exp. Zool., 121:311–326.
1953. Gonadal and fat response to a 5:1 ratio of light to darkness in the white-throated sparrow. Condor, 55:187–192.
1954. Production of repeated gonadal, fat, and molt cycles within one year in the junco and white-crowned sparrow by manipulation of day length. J. Exp. Zool., 125:353–376.

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NESTING OF THE BLUE-BLACK GRASSQUIT IN PANAMA

By GLADYS C. BARNARD

Throughout the rainy season, from about April to December, in central Panamá and the Canal Zone, the Blue-black Grassquits (*Volatinia jacarina*) are a common sight as they feed on the seeds of the tall roadside grasses or in open lowlands. Notes on their nesting were made chiefly at the edge of the townsite of Pedro Miguel in the Canal Zone, on a hillside beside a second-growth jungle and at an elevation of about one hundred feet, seven miles inland from the Pacific end of the Panama Canal. Additional notes were made at an elevation of 30 to 50 feet on the western side of Ancon Hill, Balboa, Canal Zone, near the Pacific end of the canal, and beside it, at Gamboa, sixteen miles inland.

Nest 1.—On August 13, 1952, a male Volatinia was seen furtively gathering nesting material in the fern row below the front entrance of the writer's home at Pedro Miguel. One week later, on August 21, the nest was discovered about five and one-half feet above the ground in a *Codiaeum* bush (*C. variegatum,* comonly called croton), which was part of a short hedge shaded by an overhanging mango tree west of the house. The nest was a three-inch, unlined, open cup, formed of dried fern midribs. Although it seemed too frail to support eggs or young, the female was found sitting on it on August 22. The male was first seen to "dance" on the following day. In this characteristic performance he springs straight up from his perch, while uttering a sharp, upward inflected *tsee-ee-eep!,* executes a flipping turn at a height which varies from a few inches to two or three feet, and drops back again to his original post. This action is repeated at varying intervals and for longer or shorter periods of time. On August 25, two blue eggs, streaked with dusky were noted. These were taken from the nest, presumably by an unidentified night prowler, on August 29.

Nest 2.—On September 3, 1952, five days later, it was discovered that the pair of Volatinias had torn apart their first nest and moved all but a few shreds of it to a gardenia shrub in the more open yard. The new site was only four feet above the ground and about ten yards distant from the first site. Late in the day, at 6:05 p.m., the pair visited a new feeding tray established for their benefit. On September 5 the male stationed himself on a branch of frangipani (*Plumeria acutifolia*) about 15 feet from the nest and repeated his dance. The hurried and incomplete notes of that year do not record visits to the nest on September 4 and 5, but they do record three eggs in the nest at 4:00 p.m. on September 6. On September 11, there was a noticeable increase in the excitement of the male as he continued the jumping flights at 5- to 6-second intervals throughout much of the day. On the afternoon of September 16, the male was seen sitting on the nest while the female ate at the seedtray. In a few minutes she returned to the nest and the male went back to his post on the bare frangipani branch to resume the dancing. As I did not examine the nest then, or on the two following days, it is quite possible that at least one of the eggs had already hatched. I finally ventured to look on September 18 and found three black-skinned nestlings. This incubation period probably was about twelve days. The male bird now ceased his flights and devoted himself to feeding the young. By September 25, at 8:00 a.m., the young completely filled the nest and were fairly well-fledged. When visited at 4:30 p.m. on the same day, the nest was empty. The young could not be found in the vicinity. If they had not been destroyed by an enemy, they must have left the nest after a nestling period of only seven to nine days. The parent birds appeared in the frangipani over my head on a branch, where the male jumped again a few times, on September 27 and 28. The female came once more to the feeder, and then the pair temporarily disappeared from the yard.

Although males of the species were seen at slightly higher altitudes during October and November of that year, none came to the feeding station until the following January 17, 1953. One male reappeared on that day and another came on February 11 with a female or young bird and hid in the thick vine of *Thunbergia grandiflora* below the kitchen window where there was a bamboo trough containing commercial birdseed. On February 16, one with a prominent white wingspot arrived and all of these birds continued to accept our hospitality while molting. On March 15 a small flock fed on the lower lawn and in a new growth of tall grass beyond the drainage ditch west of the garden. On April 9, a male was seen to jump for a while at 4- to 6-second intervals and similar activity was reported on the following day from Balboa. This was the first jumping of the season which had been observed there.

Nest 3.—One week earlier in the month than in the previous year, on August 7, 1953, the Blue-black Grassquits returned. It was later reported to me that a pair had nested earlier near the house on the hill above us. They were first seen stripping fibres from the matting, trunk and tough midribs of the fronds of a young coconut palm beyond the garden. At 7:30 a.m. on August 11, the male, which had been lingering under the hedge, was seen to jump in the open space beyond it. Ten minutes later he was at the site of the unsuccessful nesting of 1952. A female sat nearby. On August 13, two male Blue-black Grassquits and the one female were seen in the garden. One of the males started to jump but the female chased it away. Next morning both males were dancing. One sat about five feet from the ground at the top of a makeshift ladder beneath a papaya tree. The other seemed to imitate his every move from the crown of a small papaya plant, at the same level. That day, August 14, 1953, a poorly assembled nest was found in the same shrub as that used in 1952, but this nest was placed about one foot higher. The structure seemed unfinished, so was not examined lest the birds desert it. We saw both males jumping on August 15 and 16, and found to our surprise, at midday of the latter day, that there were already three eggs in the loose cup-shaped nest. After that the older-appearing male danced alone until August 26, when two nestlings and one unhatched egg were found at noon. At 3:00 p.m. on August 26, the male bird came to the feeding tray and ravenously dipped into it more than 32 times before resuming his flights from the ladder. The female continued to brood and the male to jump until August 30. At noon I removed the unhatched egg and found it to be infertile. At 2:30 p.m. the male was seen approaching the nest with an inch-long green worm, and soon after the female arrived with food for the young. By September 1 the young were well grown and at 10:00 a.m. on September 4, 1953, about nine days after hatching, they were missing from the nest. When I looked into it, the parents came hopping from under the house. The male worked for a while at tearing the nest apart at 9:30 a.m. the next day. That afternoon he came, for the first time, to a feeding tray on the remote side of the house. At 6:00 p.m. the adults were seen gathering something in the grass and flying with it toward the brush. On September 8 at 8:15 a.m., two fluttering fledglings were brought by their mother to a tree above the tray and fed. Later this female drove away a male Variable Seedeater (*Sporophila aurita*) and led the young to the feeder itself. The male was seen sitting on "his" ladder for the last time at 1:30 p.m. that day. The pair was noted feeding under the hedge eleven days later. A lone male jumped in the garden on December 6 but both the Blue-black Grassquits and the Yellow-bellied Seedeaters (*Sporophila nigricollis*) seemed to have left the vicinity about September 25, 1953.

Nest 4.—The Volatinias returned to what was apparently their nesting territory from their haunts of the early part of the dry season as follows: On January 17, 1954, same date as in 1953, a pair was seen at the foot of the hillside drainage ditch; one black

individual appeared at the feeding tray at 7:30 a.m., on March 3, 1954; two others with a female were seen feeding in the garden. These birds were still in the process of molting and they hid in the vines, coming timidly before sunrise to the tray by the kitchen window, which had been frequented during their absence by a small flock of Variable Seedeaters. One shy, rusty-feathered, young male grassquit fed on the seed which had fallen or been spilled on the ground. By May 18 his plumage was noticeably blacker, and by the last day of the month he was seen jumping. Ten days later, June 10, 1954, his nest was found in a rashly exposed situation at the top of a fish-tail fern (*Nephrolepis* sp.) about two feet above the ground. In it was one egg, half pale-blue and half white, streaked with dusky. The female had sat on it for only one day before it was found, punctured, on the ground. A pair of wrens, one pair of Variable Seedeaters and at least two pairs of Yellow-bellied Seedeaters had disputed the area with the newcomers. The male, an immature or first-year Blue-black Grassquit, may have been the one seen jumping in the garden a few days later, but that was the last known attempt of this species at nesting in the immediate vicinity of the house.

Additional notes.—In Balboa during May, 1955, a pair of Volatinias started coming to our feeding tray at the corner of the patio. The male jumped on June 12, but no nest was found. The pair both fed regularly and then more frequently, as though feeding young, for some time prior to August 6, 1955. On that date, the female brought young to a tall tree nearby and fed them. The frayed-looking male disappeared that day, and the female disappeared a few days later on August 11. A male was seen a few days later in the brush beside a ditch further up the hill.

On October 8, 1955, a nest was seen and photographed at the top of a bank behind the home of its finder, Mrs. W. M. Alderton, of Gamboa, Canal Zone. The usual scanty, cup-like nest was hidden in short, matted grasses which arched above it in a half-dome. There were three fledglings in it. Mrs. Alderton observed that the male jumped for eight days and both parents cautiously fed the young for nine days before the third young bird left the nest.

SUMMARY

The Blue-black Grassquit nested four times, within a period of three years, near a house in Pedro Miguel, Canal Zone. Nesting was observed in the months of June, August, September, and October.

The nest constructed by these birds is an unlined, open cup, about three inches in diameter, with only a few stiff fibres forming the bottom. One nest was found in the short grass, and others were noted from two to six and one-half feet above the ground. Nests were built in August of two consecutive years in almost the same spot. In one instance, after the young were destroyed, the nest was moved 10 yards to another site. The following year a successful nest on the original site was partly destroyed after use.

Two or three eggs are laid. These are pale blue in color and are streaked with dusky.

The male was once seen, near the end of the incubation period, replacing the female at the nest while she fed. The male assisted in feeding the nestlings. Nestling periods of nine days were noted twice.

Balboa, Canal Zone, November 1, 1955.

FROM FIELD AND STUDY

Evidence of Double-brooding in Gambel Quail.—The Gambel Quail (*Lophortyx gambelii*) is the only abundant resident game bird on the hot, arid, shrub desert of southern Nevada, western Arizona, and southeastern California. It normally raises one brood of young a season, if it nests at all (Macgregor and Imlay, Calif. Fish and Game, 37, 1951:218–219). Gorsuch (Univ. Ariz. Biol. Sci. Bull., 2, 1934:25–27) points out that time limitations make two broods in a single nesting season out of the question, assuming that the brood will be kept intact and with its parents until the chicks are fully grown. Gorsuch's statement is valid under normal environmental conditions. However, food conditions on the Mohave Desert ranges of Clark County, Nevada, developed so favorably in the fall of 1951 and the winter of 1952, when 7.09 inches of precipitation fell at Searchlight, that Gorsuch's basic assumption did not hold.

The first indication that something other than normal productivity was occurring came to my attention on June 6, 1952, when a flock of 54 Gambel Quail chicks of age class III were flushed from a cave beside a wash below Granite Springs, on the Nevada-California border, 12 miles southwest of Davis Dam, Nevada. In spite of careful pursuit and examination of this flock of chicks, not an adult quail could be found among the lot. Then, on June 28, at quail guzzler MO–6, in the Mormon Mountains, 26 miles north of Overton, all three broods coming in to the guzzler were accompanied only by single adult males; one was a group of 30 class III young, another a brood of 10 class II young, and the third a brood of one, a class II young.

Several additional observations made at other guzzlers in early July, 1952, shed further light on this matter (table 1). These observations were part of the standardized water hole counts, used by Nevada Fish and Game Commission personnel, to determine population trends. They commence one-half hour before sunrise and end five hours after sun-up.

Table 1

Brood Composition at Guzzlers in Southern Nevada in 1952

Site[1]	Date	♂ and ♀ with jvs.		♂ with jvs.		♀ with jvs.		♂ and ♀ without young	"Weaned" young	Average brood sizes with adults	"weaned"
MO–6	6/28	0	....	3	41	0	....	5	0	13.6	.....
N–4	7/3	7	77	1	14	5	48	12	142	10.7	11.8
GB–4	7/8	4	48	2	17	2	11	6	80	9.5	13.3
D–2	7/11	3	39	5	53	0	....	15	260	11.5	17.3
D–16	7/12	1	11	2	12	1	12	2	92	8.7	?
Totals		15	175	13	137	8	71	40	574	10.6	14.4

[1] Location of guzzlers: MO-6, 26 mi. N Overton; N-4, 5 mi. E Searchlight; GB-4, 22 mi. SSE Overton; D-2, 10 mi. WSW Davis Dam; D-16, 12 mi. NW Davis Dam.

Nesting commenced in February, 1952, with the first peak of hatching in mid-April. This early hatching peak was at the height of productivity of the 1952 food crop, and apparently many adults took advantage of this condition to bring off another brood. The second nestings were just a week or two later than the normal nesting timetable for southern Nevada's desert regions, with the second hatching peak coming in early July.

Adults had to free themselves of their earlier broods if they were to renest while feed conditions were still favorable. Two methods appeared to be in use in 1952 to achieve this end: (1) to delegate the care of broods to the males, or (2) to "wean" the chicks and let them take care of themselves. This latter method seemed to be the most prevalent; even broods about four weeks old were "weaned" and left in the "care" of groups of older birds of the year. Of 979 young quail counted at five guzzlers in southern Nevada between June 28 and July 12, 1952, 59.9 per cent had been "weaned" and were apparently completely independent of any parental care (table 2).

The observation was repeatedly made that earliest arrivals at water in the morning (4:40 to 5:20 a.m. PST; sunrise about 4:30 a.m.) were paired quail without broods. These pairs seldom spent more than five to ten minutes in the vicinity of the guzzler and departed by the same route by which

they had approached. These were believed to have been nesting birds, most probably incubating their second clutch of the season. Next, about 5:30 a.m., the groups of independent juvenal quail began swarming in to water. They came in flocks of as few as 2 to as many as 73 birds. Generally the larger flocks included young quail of two or three age classes. Unlike the nesting birds, these young had nothing to do but loaf around the water, and oftentimes over 100 young quail would be loafing within

Table 2

Age Classes of Young Quail at Guzzlers in Southern Nevada in 1952

	Chicks with parents				"Weaned" chicks		
Age classes[1]	I	II	III	IV	II	III	IV
MO–6	0	11	30	0	0	0	0
N–4	23	41	28	48	0	43	99
GB–4	17	42	24	2	0	8	80
D–2	32	60	0	0	0	54	206
D–16	35	0	0	0	9	33	54
Totals	107	154	82	50	9	138	439
Percentage of total young	10.9	15.7	8.4	5.1	0.9	14.1	44.9

[1] Age classes: I, newly hatched to 2 weeks old, downy young, no feathers, no tail, very little if any plume, flightless; II, 2 to 4 weeks old, one-third to one-half grown, wing and some body feathers developed, short tail, small plume, light faced, flying; III, 5 to 8 weeks old, three-fourths grown, body well feathered, tail and plume one-half grown, light face and head; IV, 9 to 12 weeks old, adult proportions to plumage but still notably smaller, still short plumed, gray faced, with males showing developing black faces and red caps.

a few dozen feet of the guzzler. Later, usually about 6:30 a.m., pairs with broods began appearing at water. Adults with broods invariably came directly in to water, methodically clearing the unit of all the independent juveniles to enable their brood to water unmolested. Once watering was completed, the brood was taken away from the guzzler.

Computing the average size of broods with parents, a figure of 10.6 chicks per brood was obtained (table 1). Further assuming that the "weaned" chicks had belonged to the adults coming to water without broods, an average figure of 14.4 chicks per brood was obtained, which compares favorably with average sizes of known broods.

The fact that 13 cocks brought broods to water alone, whereas only 8 hens did this, is believed to be significant, indicating a certain number of hens renesting while care of the earlier brood was delegated to the cocks. This seemed especially true at guzzlers MO–6 and D–2.

The data presented in table 2 are believed to be further evidence supporting the double-brooding thesis. Almost 45 per cent of the quail chicks counted in late June and early July, 1952, had been hatched in April and were independent, whereas only 40.1 per cent of the chicks were still in broods with their parents, and nearly two-thirds of these were less than about one month old.

Unfortunately, the conclusive proof, that of two broods being produced by individually marked quail in one season, has not been obtained. The evidence is entirely circumstantial, based upon the data presented here.

This condition of probable double-brooding existed over most of the desert ranges of Clark County in 1952, but it seemed to be most common in the southern part of the county, from Searchlight south through the Dead Mountains to the California state-line north of Needles. There was no evidence of "weaning" or double-brooding among Gambel Quail that occupied valley habitats in southern Nevada. On the desert ranges where double-brooding was evident the average production was nearly 15 chicks per adult pair, whereas it amounted to only about 10 chicks per pair in the valley areas. The response of the quail population was irruptive on the desert ranges, there being about 800 quail in mid-July, 1952, where there had been only 100 quail four months earlier.

No evidence of double-brooding was noted in southern Nevada in 1950, 1951, 1953, or 1955, but there was some evidence of "weaning," and perhaps double-brooding, at four different watering sites in 1954. This was too infrequent to be of importance in overall quail population dynamics in 1954, since the average desert range productivity was only 475 young per 100 adults.

One interesting sidelight of the early nesting season in 1952 was the observation, at guzzler D–16, of three adult males (one a tagged transplant released at this site on December 13, 1950) paired to nearly fully grown class IV females. There was no evidence that this "pairing" was any more than a short-lived companionship.—GORDON W. GULLION, *Nevada Fish and Game Commission, Elko, Nevada, January 14, 1956.*

A Fossil Guan from the Oligocene of South Dakota.—It is of much interest to record another fossil species of the strictly American family Cracidae of the order of gallinaceous birds, especially since this record extends the historical distribution of the Cracidae back into the Upper Oligocene. The specimen, while only a fragment, is typical in the form of the condyles of the humerus and in their relation to one another. Dr. James D. Bump who collected the type informs me that it was found alone without association with other fossils. The characters shown in the bone are of such a nature that it does not fall within the limits of the genera previously known. Its detailed description follows:

Palaeonossax new genus

Characters.—Distal end of humerus similar to *Ortalis* Merrem, but with entepicondyle reduced in size, and with more definite separation from internal condyle; internal condyle relatively smaller; external condyle relatively shorter and slightly broader; entire distal end more delicate, less swollen.

Type.—Palaeonossax senectus.

Palaeonossax senectus new species

Characters.—Distal end of humerus (fig. 1) similar to that of living *Ortalis vetula* (Wagler), but less inflated; internal condyle smaller, more rounded; external condyle slightly shorter and definitely broader; other characters as indicated in the generic diagnosis.

Type.—Distal end of right humerus, South Dakota School of Mines and Technology, Museum of Geology no. 457, from Upper Oligocene (Upper Brule formation): Protoceras Channel Sandstone, 5 miles south of Scenic, South Dakota.

Measurements.—Transverse breadth across trochlea 11.1; smallest transverse breadth of shaft 6.3 mm.

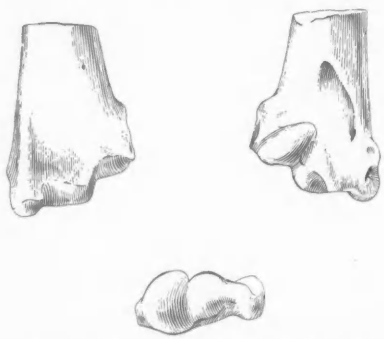

Fig. 1. Distal end of right humerus of type of *Palaeonossax senectus,* × 2.

This specimen, although fragmentary, is definitely representative of the family Cracidae in the order Galliformes and is the most ancient record of this group that has been found. The 11 genera of living forms range from the lower Rio Grande valley in Texas and northern México south through Central America and South America to northern Argentina. Four fossil species have been described previously from Tertiary deposits in Nebraska, South Dakota, and Florida, as follows: *Ortalis phengites* Wetmore, Lower Pliocene, Nebraska; *Ortalis tantala* Wetmore, Lower Miocene (Lower Harrison beds), Nebraska; *Ortalis pollicaris* A. H. Miller, Lower Miocene (Rosebud beds), South Dakota; *Boreortalis laesslei* Brodkorb, Lower Miocene (Hawthorn formation), Florida.

There are records also for the group from Pleistocene cave deposits in Brazil, which however are identified only to genus: *Crax,* a curassow, and *Penelope,* a guan (identity apparently not certain). There should be mentioned also the related *Gallinuloides wyomingensis* Eastman, from the Middle Eocene (Green River formation) of Wyoming, which is placed in a separate family, the Gallinuloididae, but in the same superfamily, the Cracoidea. The Cracidae as a whole are known only from the western hemisphere and from present evidence may have had their center of development in North America. It must be pointed out, however, that little is known yet of the Tertiary avifauna of South America and also that most of the 45 or more living species, including the more specialized kinds, are found in or near the great Amazon-Orinoco basin of that continent. Cracids are most abundant in the tropical zone, but they range also into the subtropical and even the temperate zones in the mountains. The living species are arboreal, living and nesting in trees, and when found casually on the ground immediately take refuge in higher cover above.

The present specimen, as the oldest record for the family, adds definitely to our knowledge of the group. In its study I have made comparison principally with *Crax rubra, Mitu mitu, Penelope purpurascens, Penelope superciliaris, Ortalis vetula* and *Ortalis canicollis.*—ALEXANDER WETMORE, *Smithsonian Institution, Washington, D.C., November 15, 1955.*

Occurrence of the Aleutian Tern and Rustic Bunting in the Aleutian Islands.—During a 14-month tour of duty on Adak Island in the Aleutian Island chain, from August, 1950, to November, 1951, I compiled notes on the birds seen on weekly trips over a route including Kuluk Bay, a large salt water lagoon (Clam Lagoon), the Bering Sea front, the slopes of Mount Moffett, Mitt Lake, and several small unnamed fresh water lakes (for localities, see Taber, Condor, 48, 1946:272). One significant observation made was that the Aleutian Tern (*Sterna aleutica*) does in fact breed in the Aleutian Islands. Bent had stated (U. S. Nat. Mus. Bull., no. 113, 1921:265) that "the name Aleutian tern is a misnomer, based on an erroneous theory that it would be found breeding among those islands; but none of the various explorers who have visited that region [has] succeeded in finding it." Clark (The Aleutian Islands: Their People and Natural History, 1945:43) reports that "the so-called Aleutian tern . . . has not been found in the Aleutian Islands proper, though Mr. Murie has a record of its nesting on the eastern border of Unimak."

On Adak I found the Aleutian Tern arriving on May 20 in company with Arctic Terns (*Sterna paradisaea*). The two species appeared to be completely integrated in their feeding on Clam Lagoon. This association had been noted by Turner (Contr. Nat. Hist. Alaska, part V, Birds, 1886:127) both in relation to nesting habits and procurement of food at Saint Michaels on Norton Sound on the mainland of Alaska. He reports the arrival of Aleutian Terns there on June 1. Nelson (Rept. Nat. Hist. Coll. Alaska, 1887:59) said they reach Saint Michaels from May 20 to 30, rarely earlier than the first date, and are found scattered along the coast in company with the Arctic Tern.

The Arctic and Aleutian terns on Adak numbered about 200. In spite of the obvious difference in the two species, it was difficult for me to distinguish them until they alighted. I took several hundred feet of colored film of these terns with a telephoto lens and on reviewing the film I cannot properly distinguish the birds in flight. In a mixed flock one can hear a harsh rasping guttural note that apparently is that of the Arctic Tern and a peeping note that probably is that of the Aleutian Tern. I think that both species nest on Adak as I saw them flying about carrying small fingerlings in their bills; however, I did not find any nests nor see any young birds. It seems unlikely that they stayed there all summer in large numbers and were non-nesting birds. The Arctic and Aleutian terns were last seen on August 12.

A second observation worthy of note was that of a flock of five Rustic Buntings (*Emberiza rustica*) on October 22 on a spit between the Bering Sea and Clam Lagoon. It is interesting that Bent (Smith. Misc. Coll., 56, no. 32:19) saw two or three on Adak in 1911 and Alexander Wetmore collected one on Kiska in the same year. As far as I know, this is the second published account of this Asiatic straggler in North America.—WALTER M. WEBER, *United States Naval Hospital, Annapolis, Maryland, December 5, 1955.*

A Transitorily Albinistic Robin Produces Normal Offspring.—Albinism, like most other aberrations of coloration, is commonly thought to be caused exclusively by genetic factors. But an albinistic bird's reversion to normal coloration would seem to suggest the operation of some influence

other than a genetic one. Hutt (Genetics of the Fowl, 1949:183) cites several instances of depigmentation of hens that later reassumed normal coloration; these variations seem to have been caused only partly by genetic factors. Groody and Groody (Science, 1942:655–656) report partial feather depigmentation experimentally induced in black Minorca chicks by a diet deficient in pantothenic acid. Frazier (Bird-banding, 23, 1952:114) attributes the partial depigmentation of a previously normal male Robin (*Turdus migratorius*) to physiological causes. The reverse of this situation, in an albinistic Robin which acquired normal pigmentation, is reported here.

On April 22, 1955, I observed a partially albinic Robin constructing a nest on a sheltered ledge on the porch of a house at 1216 East Fifth South Street, Salt Lake City, Utah, the home of Mrs. S. G. Paul. She reported that the bird had first appeared in the neighborhood on March 27 and that it had begun the nest on April 21. I am indebted to her for her interest and prolonged observations.

At the time I first saw the bird, the underparts were largely white. A few horizontal lines of red appeared on the breast, and the sides and belly were mostly red, with some white blotches interspersed. The throat was normally patterned. The back and head were mainly white, with longitudinal streaks of gray, which were larger and more prominent on the back. The wings were mostly gray, especially at the tips of the primaries. Only one of the rectrices was not white. The eye was black, and the bill was yellow. This description closely fits that of a Robin now in the collection of the University of Utah, which was taken in mid-April, 1955, at Nephi, Juab County, Utah.

Mrs. Paul first noticed a male Robin near her albino on April 25; it was of normal appearance. The albino completed the nest by the next day. Presumably the two birds were mated at this time. Two eggs were laid in the nest, on May 9 and 11. They hatched between May 23 and 26. Inasmuch as only the albinistic bird of the pair was seen to work on the nest or to alight on it during incubation, it may be inferred that this bird was a female. Tyler (in Bent, U. S. Nat. Mus. Bull. 196, 1949: 20–21) states that the female of the eastern race usually assumes both these tasks. However, Mrs. Paul noted on May 28 that the albino and the normal Robins were alternating on the nest. The young were fledged on June 8. Neither Mrs. Paul nor I could discern any tendency toward albinism or other abnormalities of plumage in the young. On June 9, both parents were observed feeding the fledglings near the nest.

After the young Robins left the nest, I was absent in the field. Up to that time, while I had the albino under frequent observation, its plumage remained unchanged. The remainder of this account is based upon the report of Mrs. Paul. On June 30, the albinistic Robin began renovating the nest, and three eggs were found in it about July 3. The three young were fledged on July 27, 29, and 31. This brood, like the first, was normally colored, although the breast of one was somewhat lighter than those of the other two.

The adult albino began to become generally darker as the annual fall molt commenced about the time the second brood was fledged, and by August 20 all of the plumage was colored normally, except for the under wing-coverts and tail, which were still partly white. This assumption of normal coloration was gradual. That this was the same bird seems to have been established by the frequency of Mrs. Paul's observations while the change was taking place.

Thus we have an instance of the disappearance of albinistic characteristics in a feral bird.—Jon Ghiselin, *Department of Zoology, University of Utah, Salt Lake City, Utah, January 10, 1956.*

Heavy Parasitization of Blue Grosbeaks by Cowbirds in California.—In four separate seasons, from 1948 to 1951, I observed and kept notes on a small group of Blue Grosbeaks (*Guiraca caerulea*) which nested along the edges of a small tidal bay near Balboa in Orange County, California. They were first located when one nest with eggs was found on June 6, 1948. Further search revealed three more nests nearby. All the nests were in first year black willow (*Salix nigra*) and varied in height from 3 to 7 feet. The nests were constructed of grasses and the seed heads of several plants, including seaside heliotrope (*Heliotropium cutassavacum*); they were lined with finer vegetable fibres.

The following year I again visited the area and found seven nests of this species. All were heavily parasitized by the Brown-headed Cowbird (*Molothrus ater*). At least three separate cowbirds had laid eggs in these nests, since the individual eggs of each were distinctive.

Nest 1 was about 5 feet up in the first-year willow growth and when found on June 11, 1949, it contained one egg. On June 19 it contained three grosbeak eggs and one cowbird egg. On July 25 the

Fig. 1. Nest of Blue Grosbeaks with three different types of eggs of the Brown-headed Cowbird; June 19, 1949, near Balboa, California.

nest contained two cowbird eggs and one grosbeak egg. Cowbird egg A was ovate, 18.5×15 mm., and was heavily blotched. Cowbird egg B measured 20×15 mm. and was very finely speckled, ovate at one end, oval at the other end. On July 14 this nest contained one young cowbird and no grosbeaks.

Nest 2 was in the process of construction on June 11. It was located 4 feet up in a main crotch of new willow growth. On June 19 it contained two grosbeak eggs and one cowbird egg. Cowbird egg C was much smaller than the others, measuring 16×11.5 mm. On June 25 this nest contained one grosbeak egg and three cowbird eggs—one each of cowbird eggs A, B and C (fig. 1). On July 14 this nest was empty.

Nest 3 was in the process of construction on June 11. It was located 4½ feet from the ground in a dense clump of new growth willow. On June 19 it contained three grosbeak eggs. On June 25 it contained one grosbeak egg and one cowbird egg A and one cowbird egg B. On July 14 it contained one young grosbeak and one young cowbird.

Nest 4 was in the process of construction on June 11. It was located 4 feet from the ground in a dense clump of willows about 50 feet from nest 3. On June 19 it contained two grosbeak eggs. On June 25 it contained two grosbeak eggs and two cowbird eggs—one each of cowbirds A and B. On July 14 it contained one young cowbird.

Nest 5 was found on July 2 and contained two grosbeak eggs. It was 6 feet up in a willow clump about 150 feet from nest 3. On July 3 it contained one grosbeak egg and one cowbird egg A. On July 14 it was empty and deserted.

Nest 6 was found on July 2, 4½ feet from the ground in a willow. It contained three grosbeak eggs. On July 3 it contained two grosbeak eggs and one cowbird egg A. On July 14 it contained one young grosbeak and one cowbird egg A which was pipped.

Nest 7 was found on July 14, 5 feet up in a willow. It contained two young cowbirds.

Since the California race of the Blue Grosbeak is a relatively uncommon bird, it is of interest to note that in 7 nestings in this area in 1949 the grosbeaks were able to raise a total of but two young.

Cowbird parasitization appeared to be about the same in the other years that I have visited the locality, but since I made few visits during the other seasons, my notes are too incomplete to afford an estimate of nesting success.—DON BLEITZ, *Los Angeles, California, October 18, 1955.*

A Northern Nesting Station for the White-tailed Kite.—When I took up residence at Corning, Tehama County, California, in 1948, I noted a pair of White-tailed Kites hunting in the area. In the next two years I located its nest in an eucalyptus grove about a mile north of my ranch. In 1954 the kites built in an olive grove, selecting a tree near the center of the grove and placing the nest about 20 feet off the ground. In 1955 they again built in an olive tree about 18 feet off the ground, and on May 10 they had three eggs. On the 17th there were four eggs, three of which hatched about June 12. Two left the nest site early and the third stayed in and around the tree for about two weeks.

Although kites have been reported north to Shasta County in the Sacramento Valley, successful nesting of the species seems not to have been recorded north of the lower section of the valley.—WARREN LABARTHE, *Corning, California, February 29, 1956.*

Piñon Jays West of the Sierra Nevadan Divide in California.—In the late summer and fall of 1955, several observations of Piñon Jays (*Gymnorhinus cyanocephalus*) were made on the west slope of the central Sierra Nevada, California, an area seldom visited by the species. All were at or near Kinsman Flat, a broad, flat area situated directly above and on the west side of the San Joaquin River in Madera County at 3700 feet elevation. The nearest landmarks shown on the geological survey map (Kaiser Quadrangle) are Hooker's Cove and Power House No. 8. The vegetation there consists primarily of heavy stands of chaparral 10 to 20 feet high, in which manzanita, ceanothus, mountain mahogany, interior live oak and flannel bush are predominant, and interspersed woodland consisting of Digger pines, black oaks and blue oaks.

On August 24, a flock of approximately 25 Piñon Jays was first heard and then seen. The birds remained well above the ground, stopping only in the tops of taller Digger pines. Although the flock was moving as a unit, individuals within it flew and landed independently; consequently they were more or less scattered. They flew several hundred feet between stops, frequently uttering their loud, single-note call in flight. While resting, they remained silent.

On September 12, two Piñon Jays were seen and heard flying overhead about one-half mile north of the first observation site. The latest observation was made on the east slope of Lion Point, 1½ miles to the southwest of Kinsman Flat, at an elevation of 4000 feet on October 12, when a flock of exactly 26 Piñon Jays was counted.—PETER A. JORDAN, *North Fork, California, November 3, 1955.*

An Unusual Record of the Lesser Yellow-legs in the Pacific Ocean.—On September 23, 1945, at latitude 25°, 17′ N and longitude 148°, 23′ W, some 600 miles northwest of Hawaiian Islands, I netted a Lesser Yellow-legs (*Totanus flavipes*) that landed on the flight deck of a United States naval carrier en route from the United States to Pearl Harbor. Examination showed that the bird was a female weighing 48.2 grams and with a completely empty digestive tract. The skin was preserved and is in the United States National Museum, Washington, D.C. This species has not been reported heretofore in or near Hawaiian Islands.—IRVEN O. BUSS, *State College of Washington, Pullman, Washington, December 13, 1955.*

Breeding of the Short-billed Dowitcher on the Copper River Flats, Alaska.—On June 25, 1955, six dowitchers were observed on the extensive grassy tide flats on Pete Dahl Slough, about fifteen miles southeast of Cordova, Alaska. Jack Walker of the United States Fish and Wildlife Service showed me a nest which he said was used by dowitchers and contained eggs on June 10, 1955. It was empty at the time of my visit but the actions of a pair of these birds left no doubt that young were nearby. Four specimens were collected. Two females had large, convoluted oviducts. Color pattern and measurements agree closely with descriptions of *Limnodromus griseus caurinus* (Pitelka, Univ. Calif. Publ. Zool., 50, 1950:43). Heretofore this form of the Short-billed Dowitcher has been recorded breeding only at Bristol Bay and Yakutat Bay in southern Alaska.—GEORGE E. HUDSON, *Department of Zoology, State College of Washington, Pullman, Washington, December 30, 1955.*

Blue Jay in New Mexico.—In November and December, 1955, two Blue Jays (*Cyanocitta cristata*) regularly visited food containers and a bird bath maintained at my home in Las Cruces, New Mexico. I have been resident in Las Cruces for over 30 years, and these are the first individuals of this species seen here. The species is one formerly familiar to me in the northeastern states, and because of acquaintance with the Scrub, Piñon, and Steller jays here, there can be no doubt of the identification. Since this is an occurrence southwest of the Blue Jay's normal distribution, it is worthy of record.—ISABELLE V. BIXLER, *Las Cruces, New Mexico, January 1, 1956.*

Additional Record of the Piñon Jay in México.—The only report of the Piñon Jay (*Gymnorhinus cyanocephalus*) in México other than in northern Baja California is that of a female collected by Chester C. Lamb 17 miles east of La Junta, 7500 feet, Chihuahua, on June 10, 1949 (Moore, Condor, 53, 1951:101). It is therefore desirable to report a second specimen of this species from Chihuahua, an adult male collected in the pine-oak association of the Babícora Hills, 7500 feet, Chihuahua, on December 4, 1936, by Harde D. Le Sueur. This specimen was formerly in the collection of the Texas Memorial Museum but was transferred to the Texas Natural History Collection in 1951.

I have been unable to determine the precise location of the Babícora Hills but I presume they are in the vicinity of San Miguel Babícora and San José Babícora, in the northwestern part of the state, about 160 miles south of the Mexican border and about 100 miles north-northeast of La Junta. A notation on the tag by the collector that this species is "very gregarious" would suggest that he obtained the specimen from a flock.

The seasonal status of *Gymnorhinus* in Chihuahua remains to be determined. Probably it is resident locally in western Chihuahua, but the possibility remains that it occurs south of Arizona and New Mexico only as a post-breeding wanderer.—ROBERT K. SELANDER, *Department of Zoology, University of Texas, Austin, Texas, April 6, 1956.*

NOTES AND NEWS

COOPER SOCIETY MEETINGS

NORTHERN DIVISION

MARCH.—The monthly meeting of the Northern Division of the Cooper Ornithological Society was held or March 1, 1956, at the University of California, Berkeley. New members proposed were Richard C. Banks, Museum of Vertebrate Zoology, University of California, Berkeley, California, and Stanford C. Tice, 78 Manhattan Avenue, New York 25, N. Y., both by Frank Pitelka.

President McLean stated that a meeting has been called of interested persons and organizations to help clarify the Fish and Game Code with regard to non-game birds, unprotected species, and the issuance of scientific permits.

Junea Kelly noted the receipt of the published proceedings of the 11th International Congress in Switzerland in 1954 and reviewed certain of the papers, particularly those on the development of Ornithology in the USSR in the post-war period. Donald McLean told of reports of banded waterfowl taken in interior Russia; there were nine birds from California, including White-fronted Geese and Pintail Ducks. Mrs. Kelly reported that on February 15, 1956, a dead Williamson Sapsucker was found at the Botanical Garden in Berkeley. Mr. McLean reported 40 Piñon Jays in San Jose, California. Howard Cogswell reported on the Robin census project. On January 8, 1956, nine parties of observers in a radius of one mile from the roosting site in Oakland and each stationed ¼ mile apart sighted just under 36,000 Robins.

The speaker of the evening, Mr. Victor Lewin of the Museum of Vertebrate Zoology, discussed "Some Seasonal Variables in a Population of the California Quail."—LILLIAN K. HENNINGSEN, *Secretary*.

SOUTHERN DIVISION

FEBRUARY.—The monthly meeting of the Southern Division of the Cooper Ornithological Society was held on February 28, 1956, at the Los Angeles County Museum. The following names were proposed for membership: Melvin A. Hedine, 1411 W. 69th St., Los Angeles 47, Calif., by Roland C. Ross; Mrs. James A. Kryder, 108 W. Base Line Road, Claremont, Calif., by Junea W. Kelly; Frank Demaree Robertson, 133 S. 12th St., San Jose, Calif., and Jack C. von Bloeker III, 161 W. 12th St., Los Angeles 61, Calif., by Jack C. von Bloeker, Jr.; Mrs. Frank Reinelt, 344 Arroyo Seco, Santa Cruz, Calif., John H. Brandt, Gen. Del., Durango, Colo., Eugene Kridler, Sacramento National Wildlife Refuge, Willows, Calif., L. D. La Fave, E. 1311 Longfellow, Spokane, Wash., and George D. Lakata, 1025 Cedar St., Wasco, Calif., by Francis H. Boynton; Hubert Andrew Arnold, 533 E St., Davis, Calif., Thomas D. Burleigh, College of Forestry, Univ. of Idaho, Moscow, Ida., John B. Crowell, Jr., 201-A Holden Green, Cambridge 38, Mass., and Mrs. Joseph E. P. Dunn, 1119 S. Highland Ave., Los Angeles 19, Calif., by C. V. Duff.

Dudley Ross reported two Emperor Geese at Santa Cruz on February 12.

Ed N. Harrison showed his colored motion picture, "African Safari."—DOROTHY E. GRONER, *Secretary*.

MARCH.—The monthly meeting of the Southern Division of the Cooper Ornithological Society was held on March 27, 1956, at the Los Angeles County Museum. The following names were proposed for membership: Donald S. Melstrom, 5413 Calle de Arboles, Torrance, Calif., by Kenneth E. Stager; Patricia F. Smith, 2215 Rose St., Berkeley, Calif., by John Davis; Dick Bird, 2721 Assiniboine Ave., Regina, Sask., Ethel B. Craig, Victoria Ave., Los Angeles 8, Calif., and Lyman K. Stuart, 501 W. Maple Ave., Newark, New York, by C. V. Duff.

John Baumgardt and Tom Cade discussed the absence of Prairie Falcons between Lancaster, Red Rock, and the Tehachapi Mountains, an area which is being rapidly settled, and their presence in more sparsely populated desert mountain regions. Allan Phillips of Tucson said that in Arizona he has noted that a number of Prairie Falcon nesting sites have been taken over by Duck Hawks. On March 3, Mr. and Mrs. Dudley Ross saw a male Vermilion Flycatcher and one immature Harris Sparrow at Furnace Creek, Death Valley.

C. V. Duff led a round-table discussion on the subject of placing all hawks and owls on the protected list in California.—DOROTHY E. GRONER, *Secretary*.

For Sale, Exchange, and Want Column—Each member of the Cooper Society is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line. Send advertising copy to Jack C. von Bloeker, Jr., Los Angeles City College, 855 N. Vermont Ave., Los Angeles 29, California.

WANTED—Good set of Dawson's "Birds of California," either "Sunset" or "Santa Barbara" editions.—JOHN E. TAFT, *352 Glen Ellen Dr., Ventura, Calif.*

WANTED—Aves section of Zoological Record: vol. 82, 1945; vol. 83, 1946 (two copies needed); vol. 84, 1947. Please state price. Have available an extra copy of Aves, vol. 90, 1953.—KENNETH C. PARKES, *Carnegie Museum, Pittsburgh 13, Pa.*

FOR SALE OR EXCHANGE—Will sell or exchange for other books on birds and mammals, a long run of The Auk, 1907 to 1940 (missing 1937, nos. 1 and 2; 1938, nos. 3 and 4; 1911, no. 3). My wants include: The Auk, 1942, nos. 3 and 4; The Condor, complete for 1899, 1900, 1901, 1902, and 1908, and 1917, no. 4 only.—NELSON D. HOY, *500 Sharon Ave., Sharon Hill, Pa.*

FOR SALE—Journal of Mammalogy, 1938–1955, complete, unbound, $65.00.—DEAN AMADON, *2534 Johnson Ave., Bronx 63, N.Y.*

FOR SALE—The "Tiny Tucker" Hummingbird Feeder, complete with instructions for use, $1.00, plus 15¢ postage. All profits realized from sales of this very efficient hummingbird attractor are used in maintainance of this wildlife sanctuary.—TUCKER BIRD SANCTUARY, *Box 53, Star Route, Modjeska Canyon, Orange, Calif.*

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LIFE HISTORIES OF CENTRAL AMERICAN BIRDS

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By ALEXANDER F. SKUTCH

This volume contains life histories of 40 species of birds of Central America belonging to the higher families of song birds—the finches, tanagers, troupials, wood warblers, and honeycreepers. The accounts are the work of a skilled, sensitive and patient naturalist who has devoted a quarter of a century of outdoor work to the intensive study of the varied and complex bird life of the mountains and lowlands of Latin America. All but two of the accounts are heretofore unpublished and for each of the five families a summary and a comparison of the highlights of the breeding biology of the species are given.

Dr. Skutch, the author, was trained in botany at Johns Hopkins University. In 1928 he first visited the American tropics in Panama. There soon grew in him a determination to devote his life to learning all he could of the habits of the birds of Central America. Botanical jobs and finances were always adapted to the fullest possible pursuit of this goal in bird study. After work in Honduras and Guatemala, Dr. Skutch settled in Costa Rica in 1941 on his own farm in the wild and isolated section of El General. In support of this particular writing he received a fellowship from the Guggenheim Foundation, and in 1950 he was awarded the Brewster Medal of the American Ornithologists' Union for his publications on Central American birds.

The book consists of 448 pages, and it is illustrated by Don R. Eckelberry. A group of four tanagers is shown in color and all the other species are represented by line drawings. Thirty-two photographs show nests and habitats of tropical America.

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